

ACT Workgroup Meeting Summary
 Friday, January 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	Company
Paul Jablonski	Chair of Transit Agency Subcommittee/ San Diego Metro Transit System
Rick Ramacier	Vice Chair of Transit Agency Subcommittee / Central Contra Costa Transit Authority
Dr. Abas Goodarzi	US Hybrid Corporation
Zach Kahn	BYD Coach & Bus (BYD)
Dr. Rasto Brezny	Manufacturers of Emission Controls Association (MECA)
Macy Neshati	BYD
Mike Hernandez	Monterey-Salinas Transit
Shridar Ayer	Denso Products and Services America
James Pachan	Alameda-Contra Costa Transit District
Michael Coates	Mightycomm/Nova/Volvo
Judy K Dennis	Nova Bus/Volvo Group
Chris Peeples	Alameda-Contra Costa Transit District
Jaimie Levin	Center for Transportation and the Environment
Chris Young	Cummins Pacific
Diana Vazquez	Sierra Club California
Jeff Grant	Zen Clean Energy Solutions
Daljit Bawa	Ballard Power Systems
Michael Masquelier	Wireless Advanced Vehicle Electrification
Mike Pimentel	California Transit Association
Alan Romero	Monterey Bay Unified Air Pollution Control District
David Warren	New Flyer of America
Dr. Edward Lovelace	XL Hybrids
Dr. Jimmy O'Dea	Union of Concerned Scientists
Henry Hogo	SCAQMD
F. Kent Leacock	Proterra
Joe Policarpio	Gillig
Steve Miller	Golden Gate Transit
Greg Mann	Allison Transmission
Greg Fritz	Alameda County Transportation Improvement Authority
Nico Bouwkamp	California Fuel Cell Partnership

Dave Harbour	Sacramento Regional Transit District
Len Engel	Antelope Valley Transit Authority
Alan Abbs	CAPCOA (California Air Pollution Control Officers Association)
Cliff Thorne	Orange County Transportation Authority
Bernie Kotlier	Labor Management Cooperation Committee (LMCC)
Charlie Ker	Cummins Westport Inc.
Monty Cox	City of Visalia
Jerilyn López Mendoza	Southern California Gas Company
Kevin Cook	Cummins Westport, Inc.
Sarah Rascon	Los Angeles Area Chamber of Commerce
Dr. Bradley L. Edgar	44 Energy Technologies, Inc
Todd R. Campbell	Clean Energy

This was the first meeting of the Advanced Clean Transit Workgroup. This meeting was webcast and recorded by video. 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 are the primary agenda items for the meeting:

- Introductions and goals
- Background and current rulemaking status
- Transit Agencies Subcommittee (TAS) Update
- Additional topics for discussion
 - Outreach and education
 - Total cost of ownership
 - Renewable fuels
- Areas for member input
 - Price projections for zero emission buses and low NOx engines
 - Flexibility options and regional approaches
 - Technology readiness
- Summary of action items

Introductions and goals

The Advanced Clean Transit (ACT) is being created to improve awareness of progress on the ACT regulation and to improve information sharing between impacted stakeholders. The workgroup is comprised of a wide range of stakeholders representing manufacturers, fuel providers, utilities, transit agencies and others and is expected to meet about every two months. The workgroup also has a Transit Agency

Subcommittee that will focus on reviewing and exploring transit agency issues and concerns that will report to the ACT Workgroup.

All parties that requested to be ACT Workgroup members were confirmed as active members. Meeting participants agreed that all ACT meeting will be open to all interested parties who wish to attend in person or participate by webcast. Draft meeting summaries will be sent to active members for a one week review and comment period and will be posted online after revisions are made. We also plan to record videos of all ACT Workgroup meetings and will likely hold the meetings in Sacramento.

Members are expected to regularly attend meetings in person, participate in discussions, review meeting summaries, and help provide information as needed. The ACT Workgroup should work collaboratively toward developing consensus analysis and methodologies and help collect information to address key issue and concerns through open communication.

ARB staff also summarized the following upcoming events:

- Advanced Clean Transit Technology Symposium on 2/8/2016
- Transit Agency Subcommittee meeting on 2/9/2016
- ARB Board meeting to update the status ACT rule on 2/18/16
- Workshops are being planned for April or May
- Board consideration of a staff recommendation is currently scheduled for Fall 2016.

Background and Current Rulemaking Status

ARB staff provided a recap of the need to achieve additional emissions reductions and summarized the ACT rule proposal that was presented for discussion at the last workshop in May 2015. The following is a summary:

- California faces challenging mandates to meet air quality, climate, and petroleum reduction goals. A transformation to zero and near-zero emission technologies in every sector is necessary to achieve these goals.
- The initial ARB concept for ACT would require the use of renewable fuel, low NOx engines when available, and the phase-in of zero emission buses as follows:
 - Switch to renewable fuels when fuel contracts are renewed (starting 2017)
 - Purchase low NOx engines for new bus purchases when commercially available (starting 2018)
 - Phase-in zero emission bus purchases (starting 2018), with a modest phase-in schedule with the goal of transitioning to full zero emission fleets by 2040.

- Allow flexibility for fleets to work together to meet the same goals, and provide an option for transit fleets to include all modes of transportation to meet the same goals.
- Staff is working with a subgroup of the Transit Agency Subcommittee to determine how flexibility options or regional approaches can complement regional plans for meeting sustainable communities strategies associated with sustainable communities strategies associated with SB 375.
- ARB staff agrees that transit service should not be adversely affected as a result of the regulation and has been discussing off-ramp concepts with transit fleets to address concerns with potential technology barriers. ARB expects that for small deployments of zero emission buses within a fleet, it is not likely that off-ramps will be needed, but the Executive officer would be able to address any fleet specific issues as they arise if off-ramp provisions are specified in a regulation. An example of off-ramp provision in existing ARB regulations is the PM filter extension process in the Truck and Bus regulation. The Truck and Bus regulation has language to allow for extensions for situations when PM filter retrofits are not available for an engine, when there are conflicts with safety requirements, or with insufficient space on the vehicle to install a PM retrofit.
- Potential zero emission bus technology off-ramps for discussion include concerns about limited space for infrastructure at existing bus depots, battery electric bus range limitations, concerns about the ability to get sufficient electric power to the site, and other technological feasibility concerns. ARB will prepare a draft discussion paper about off-ramps concepts to address these issues. ARB will be looking to transit fleets and others to help identify details on how off-ramps could be implemented and what information would need to be provided to support an extension request. ARB suggested that concerns about costs need to be addressed separately when there is a more complete understanding of full lifecycle costs, and reiterated that cost information and available funding opportunities will inform and shape a staff recommendation.
- ARB is collecting data from a range of sources to support the ACT proposal and will continue to collect data about advanced technology. The following is a summary of recent efforts that were discussed:
 - ARB has a contract with NREL to collect data from fast charge battery electric buses operated by Foothill Transit Agency and a report was published recently and is confirming that, while the Proterra fast charge bus availability is comparable to conventional buses. Rolling stock and infrastructure capital investments for the most recent bus purchases are lower than prior purchases, but remain significantly higher than conventional buses.
 - ARB will also be contracting to collect performance and operational data for variety of vehicles, i.e. buses, drayage, and off-road equipment that will be funded through recent ARB solicitations.

- The National Transit Database is useful for understanding general characteristics about individual transit fleets including average miles, hours, and other characteristics for different modes and vehicle categories, but it does not have details needed to understand what portion of the bus fleet can use existing zero emission buses without changing existing service requirements and to estimate what actions individual fleets would need to take to comply with a given proposal.
- ARB has been seeking comments on the ARB Transit Fleet Survey that would provide more details about individual transit fleets and their bus depots. ARB has already received comments from the TAS, individual transit agencies, CTA, and CalACT members and is making revisions. Subcommittee Members were asked to review the survey and submit comments by the end of next week. The draft survey is available on ACT website in pdf format, but will be emailed in Microsoft Word to those who prefer to make edits on an electronic version.
- ARB is also gathering information about financial incentives and opportunities, but it is still too early to talk about the role of financial incentives until costs are better understood and a specific proposal can be discussed. We still need to see if we can come to a common understanding of vehicle specific costs (including operation and maintenance), projections of future bus costs, costs for low NOx engines, etc.
- The Low Carbon Fuel Standard program is a new source of funds for transit fleets that use low carbon fuels and will be discussed at the Technology Symposium along with updates on what the California Public Utilities Commission and electric utilities may be doing to support transportation electrification.
- There was some discussion about whether zero emission bus requirements would limit funding opportunities for incentives and what ARB's funding opportunities are for university shuttle buses. This is an area that requires further evaluation regarding NOx reductions and the traditional HVIP program, but is generally not an issue for GHG emissions reductions associated with the Greenhouse Gas Reduction Fund (GGRF). The HVIP program currently administers funds from multiple sources and each source of funds has certain restrictions on how it can be disbursed. ARB is closely coordinating the rule requirements with funding program to minimize conflicts with how funding must be administered.
- ARB is already planning updates to its funding programs and will be shaping future funding programs and rules to complement each other.

Transit Agencies Subcommittee (TAS) Update

Paul Jablonski, Chair of TAS, provided update and explained the Subcommittee consists primarily of transit agencies. Transit agencies have been innovative users of advanced technologies. TAS wants to assure implementation of these technologies as regulatory requirements will not have any adverse effect on transit operations. Transit agencies have concerns about cost and readiness of technology and also feel that alternative strategies to the ACT framework need to be explored so that the most economical approach to emissions reductions can be taken. He also explained about the functions of two subgroups within the TAS. One is focused on transit fleet costs and the other on flexibility options. TAS is also open to transit agencies that are interested in contributing to this group. Finally, Rick Ramacier, Vice Chair of TAS, urged the Workgroup to consider also how service planning may change with an electrified fleet. A summary of the first TAS meeting is posted on the ACT meetings webpage at <http://www.arb.ca.gov/msprog/bus/tasmtngsumfeb92016.pdf>. The following is a summary of the TAS activities that were discussed:

- Transit fleets continue to believe a transition to a fully electrified transit fleet in California will be hugely expensive. Addressing costs and appropriate assumptions continues to be a primary issue.
- Steve Miller, who is lead of the cost subgroup, provided an update on fleet O&M cost data gathering efforts. The subgroup is working on gathering existing transit fleet data needed to estimate life cycle costs for 22 years of regulation, developing a cost model, and refining maintenance and operational costs. For battery electric buses, costs will need to be able to separately evaluate total cost of ownership for 3 different categories including fast charge, slow charge, and slow charge buses with supplemental on-route charging. Steve Miller indicated that he shared the updated spreadsheet with selected bus manufactures and individual transit fleet, and is planning to share the results with the workgroup and the TAS subcommittee in the near future.
- The subgroup that is focused on developing flexibility and regional approaches is seeking opportunities to complement regional efforts that are being implemented to meet SB 375 goals. SB 375 is a driver for transit agencies to move forward and partnering with their regional MPOs to provide more efficient transportation and reduce GHG. At the last coordination meeting with ARB we discussed that most actions that transits can take to support regional plans are already included in regional plans and would present a double counting concern. ARB still needs to internally address these double counting issues to determine how ACT could be complementary to regional plans without double counting GHG emissions reductions.
- Defining a performance-based approach. Transit agencies selected diesel or alternative fuel path previously to comply with ARB regulation and reduce NOx

and PM. Now they have green diesel, low NOx engines, and zero emission technology available. Workgroup wants to understand the benefits of these technologies and how to develop a performance-based approach to comply with ACT regulation.

- ARB is currently working to evaluate different performance based implementation strategies to discuss at future ACT workgroup meetings. There are a number of factors in play including the carbon intensity of fuels, vehicle energy efficiency, the increasing renewable electricity grid mix and goals to complement existing emission reduction programs. ARB also recognizes that long term renewable fuel supplies are limited and will also be needed in stationary, residential and industrial sources. Work that is being done for the Scoping Plan is expected to provide a perspective on renewable fuel supplies and where renewable fuels are needed.
- ARB confirmed once again all advanced technologies are needed as part of a successful State strategy that addresses all sectors and the ACT effort is only one part of a comprehensive plan.
- Clean Energy also explained they are currently working on a document to compare emission impacts of low-NOx engine accompanied with renewable fuels with electric buses.

Topics for Discussion

Outreach and education

ARB wants to make sure information is available for all parties and is transparent, especially for smaller transit agencies that might find it difficult to have access to latest information about new technology. According to workgroup, multiple NGOs and CalSTART are doing great job with helping smaller agencies. Transit agencies also willing to share lessons learned. In addition, workgroup recommended communication through CTA and CalACT to reach 98% of operators in the State.

CalACT runs joint procurement that can help smaller transit agencies with bus purchase process. Joint procurement process is getting harder to be approved by FTA. ARB should take this into consideration.

Total cost of ownership (TCO)

Total cost of ownership continues to be a key topic of discussion. ARB shared a brief discussion paper about total cost of ownership with members before the meeting. The paper covered rough estimates of the effect of declining battery prices on battery electric buses price projections, the value of credits to transit agencies from the LCFS program for all low carbon fuels, electricity costs in nine utility service areas, and identified areas where additional information is needed from ACT workgroup members.

A copy of the draft paper is at <http://www.arb.ca.gov/msprog/bus/wg201601cost.pdf>. The following is a summary of where there is consensus from Workgroup members and what additional work needs to be done:

- The cost methodology has been discussed with the TAS multiple times, and there is a consensus on the general approach and that the analysis should be based on total cost of ownership for different technologies.
- ARB will be using a 14 year life cycle period for standard transit buses to be consistent with the most common replacement cycle used by transit fleets.
- In addition to understanding general cost of ownership comparisons of different options, ARB is also planning to do case studies on individual fleets to better understand differences between fleets.
- Currently, the TAS is developing typical maintenance costs for existing buses, but there is considerable uncertainty about advance technology costs especially long-term costs and we will need further study and data analysis of in-use fleets and information from manufacturers, suppliers and others to fill in the gaps.
- The future of electricity supply and costs will be discussed by utilities at the Technology Symposium.
- The summary paper, included a very short summary of how electricity costs differs for multiple utility service areas and what standard rates would cost for slow charging at night vs fast charging during the day. The next step will be to prepare a more thorough description of how existing demand metered, time of use rates work and how electricity costs differ based on existing rates structures, charging strategy and service profile.
- Renewable fuel availability in California is increasing as a result of the LCFS program. Transit fleets that use conventional natural gas, renewable fuels or operate zero emission buses or fixed guideway systems can still register to generate credits from the first quarter of the year. The estimate value of credits is summarized in the meeting discussion document, and an overview of how to register for the LCFS program will be covered as part of the Technology Symposium.
- ARB has confirmed that any ACT requirements to use renewable natural gas (RNG) or renewable diesel fuels will not reduce the number of LCFS credits a fuel provider can claim, but the GHG reductions cannot be double counted in both regulations. The GHG emission benefits from these renewable fuels will be attributable to LCFS program.
- Similar questions were asked about whether ACT requirements to use zero emission buses would reduce LCFS credits associated with the use of electricity instead of conventional fuels. The economic value of credits generated from using electricity and hydrogen in zero emission buses is key to reducing fuel/charging costs and is an important in lowering the total cost of ownership

and staff's proposal. Zero emission bus requirements in the ACT regulation would not reduce credits a fleet owner could claim, but the GHG emissions reductions cannot be double counted in both regulations. ARB will need to clarify how to avoid double counting emissions will be addressed.

- Chris Young, a Cummins dealer confirmed the 8.9 liter low NOx engine will be commercially available in April 2016. Incremental cost of the engine in an overhaul is expected to be about \$15,000 and could have a similar incremental cost impact on new buses. The engine block is the same size, but the catalyst is a bit larger and there may need to have changes to brackets or other modifications to the engine bay. The costs would be expected to be lower with higher volumes. New Flyer will share the incremental cost of an OEM bus in appropriate time.
- ARB agrees that a low NOx engine replacement at time of rebuild would result in additional NOx reductions than ARB's initial proposal, but did not include that in the initial rule proposal in May 2015 because of uncertainty on feasibility and costs. However, the South Coast AQMD confirmed that it would not be able to provide funding from existing programs for engine repowers if they were required by the ACT rule. The SCAQMD expects to have funds available to support mid-life engine upgrades to low NOx engines and recommends that mid-life upgrades should not be required in the ACT regulation to avoid the conflict with existing funding programs.

Areas for Member Input

- Price projections for battery, ZEB, and low NOx engine bus. Price of batteries and fuel cell stacks are coming down. Volume and economy of scale have direct effect on projected price. ARB is currently working to identify the factors that reflect the future prices, including battery production costs, and bus sales volume.
- Mr. Bawa from Ballard mentioned the price of fuel cell electric buses in Europe dropped in 10 years from €3.2 million for prototypes to €650,000 (which is equivalent to \$750,000) with sales volume of only 100 buses. He expects by 2020 with volume of 300-500 buses the price of fuel cell buses will be less than €400,000. He also indicated that a recent order from China for fuel cells to be installed in buses will bring fuel cell costs down substantially, and the Chinese market for fuel cells is also going to have big effect on reducing prices. ARB requested Ballard to share this information in a citable document to share with the workgroup.
- Regarding battery prices, data developed by EPRI and NREL, price of batteries have already dropped down and it continues going down. There was some discussion about whether battery cost studies were reflecting cell prices vs.

complete pack prices and what sales volumes were being assumed. Care needs to be used in estimating current and future battery costs for buses.

- Transit fleets noted they historically have not typically seen bus price reductions because of new features and equipment added to buses.
- Europe does not have 12 year FTA requirements and buses have other specifications; however, the buses are operated by private companies and all expenses are covered by fare box revenues. In the U.S. transit operations are primarily funded through government funds.
- Transit agencies representatives indicated that they have not experienced price reductions, because there are always better and newer bus models available in the market and prices go up over time.
- Mr. Neshati from BYD mentioned overseas' price and volume have effects on US market. In 2017 BYD will have 7000 battery electric buses in the worldwide market which will have positive effect on US market. Their price today in the U.S. is already below \$800,000 and is continuing to decline. BYD is going to send ARB bus prices for each types of bus.
- The State of Washington coordinated a bus procurement contract for up 800 buses of all fuel types. The contract is good for 3 years with options for 5. The buses are all specified the same way and is an apples to apples comparison of bus prices with different propulsion technology. ARB plans to use these bus prices so that there is less chance of inappropriately comparing a base bus price to another bus price that has tens of thousands of dollars in additional options such as paint, and fare boxes.
- New Flyer mentioned the price of BEB also depends on the charging strategy of the buyer. On-route charging has higher cost infrastructure and has to be amortized over the bus price. Larger batteries for slow charge will impact bus prices. The planned Transit Fleet Survey should reveal more information about routes lengths and will be helpful in developing bus price projections.
- Use of energy storage on-site also can also have a significant effect on managing the cost of energy.
- A representative from Pacific Gas & Electric suggested that electricity costs used by ARB includes a demand charge waiver, and are therefore, lower than they would naturally be. He stated that demand charges are necessary to maintain the integrity of electricity, and that ARB may need to look at other forms of subsidies. However, ARB explained that it has only used standard commercial rates with all demand charges in its lifecycle analysis and has not factored in cost reductions associated with temporary waivers in any analysis. To date, waivers have only been used for fast charging buses. ARB specifically identifies the average costs of electricity used in its analysis so that it is clear what cost is used.

Summary of action items

- ARB will evaluate details on how to avoid double counting emissions with SB 375 and the LCFS program and will prepare a discussion paper.
- ARB will prepare an off-ramp concept paper for discussion.
- ARB will prepare a summary description of how existing time of use rates work and how electricity costs for different bus charging strategies differ by service area.
- ARB will evaluate available battery price information and update the future price projections for batteries for discussion.
- Mr. Bawa from Ballard is going to provide documentation about European market for fuel cell electric buses and expected costs for a projected sales volume. He also suggested using European studies for various propulsion systems, such as battery electric, fuel cell, diesel electric hybrids, and CNG. He is going to share documents with the workgroup.
- Mr. Neshati from BYD is going to provide price information for each of their bus types and will provide some estimation about how their bus prices will decrease with higher sales.
- ARB still needs updated information about fuel station costs, including for hydrogen and natural gas fueling and will be seeking information from members.