Advanced Clean Transit in California

Los Angeles Area Chamber of Commerce

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Mobile Source Control Division
California Air Resources Board

California Environmental Protection Agency

Air Resources Board
Driving Change

- Significant reductions needed to meet air quality and climate goals
  - Meet federal health-based ambient air quality standards
  - 40% reduction in GHGs by 2030
  - 80% reduction in GHGs by 2050
  - Up to 50% petroleum use reduction by 2030
- Achieving goals will require a transformational change in all sectors
  - Stationary, industrial, mobile, other
All Possible Methods Needed to Meet Goals

- Increased efficiencies
- Cleaner combustion
- Cleaner fuels
- Zero emission vehicles
- In-use controls
- Other
Long-term Transformation for Mobile Sources

“Zero emission equipment everywhere feasible, and near-zero emission equipment powered by clean low-carbon renewable fuels everywhere else.”

--Sustainable Freight: Pathways to Zero and Near-Zero Emissions (Discussion Draft, April 2015)
Coordination Efforts

- Collaborating with transit and regional agencies
- Working closely with funding programs and partners
- Developing standards
- Engagement with technology and bus manufacturers
- Coordination with utilities
- Coordination with other programs
  - Sustainable Communities Strategies (SB 375)
  - Sustainable Freight Strategies
Transit Agency Mission

- Provide safe, reliable and affordable public transit service, including in disadvantaged communities
- Help meet future population growth needs
- Reduce traffic congestion, urban parking, and local air quality issues
- Help achieve climate goals
- Promote better land use
- Provide emergency transportation
Existing Transit Fleet Rule

- Initially adopted in 2000; transit fleets first to transition to alternative fuels or diesel particulate filters
- Significant reductions in diesel PM and NOx emissions from transit fleets
- Two fuel paths: diesel path or alternative-fuel path
- Includes long-term zero emission bus purchase requirement
  - Purchase requirement on hold pending bus technology assessment (Resolution 09-49)
Technology Assessment

- Update in November 2015
- Both battery and fuel cell electric buses are commercially available for transit applications
- Significant technology advancements since 2009
  - Increased reliability & availability
  - Declining costs
  - Improved performance
  - Extended mileage range
Vision for Future Transit

- Use most efficient transportation technologies
- Enhance service for disadvantaged communities
- Seamless integration between modes and transit systems
- Enhanced mobility with innovation
- Continue to provide efficient, safe, and affordable transit services across California
Advanced Clean Transit Concept

- Mix of cleaner combustion & zero-emission buses
  - Low NOx engines and renewable fuels
  - Transition to zero-emission buses by 2040
- Natural fleet replacement rate (not accelerated)
- Flexibility for regional collaboration and opportunity for greater efficiencies in transporting passengers
Established Workgroups and Enhanced Outreach

- Advanced Clean Transit Workgroup
  - Transit Agency Subcommittee
- Technology Symposium
- Board members and staff visiting transit agencies to better understand experiences and concerns
Near-Zero Emissions

- **Low NOx engines**
  - First CNG engine 90% lower NOx commercial in spring 2016
  - Diesel engines not yet available

- **Renewable Fuels**
  - Greenhouse gas benefit (LCFS)
  - Long-term supply issue
Zero-Emission Fuel Cell Electric Bus

- AC Transit, Sunline Transit
- Excellent range, improved durability
- Fueling time comparable to diesel fueling
- Hydrogen price is comparable to diesel with large throughput
- Bus still costly at low volumes
Zero-Emission Battery Electric Bus
(Slow Charge)

- Antelope Valley Transit, LA Metro, Long Beach Transit, and Santa Barbara MTD
- About 160 miles per charge (3-4 hours)
- Charging infrastructure is inexpensive
- Potential fuel and maintenance cost savings
- Range constraint
Zero-Emission Battery Electric Bus (Fast Charge)

- San Joaquin RTD, Foothill Transit
- On-route fast charging (3-10 min) = unlimited range
- Charging infrastructure is more expensive
- Potential fuel and maintenance cost savings
- Fixed routes
Zero Emission Bus Market Ready to Expand

- Ten California fleets operating zero emission buses
  - Several fleets adding zero emission buses this year
- Number of zero emission buses to more than double in California this year
- Ten bus manufacturers offering dozens of models in various bus categories and sizes
- Five zero emission bus manufacturing facilities in California
- United States and world market expanding
Most Manufacturers Offer Zero Emission Buses

- **Nova Bus**
  - 15%
  - Battery electric bus option in existing platform

- **Gillig**
  - 33%
  - Currently demonstrating battery electric bus in existing hybrid electric platform

- **Others (BYD, Proterra, El Dorado, GreenPower, etc.)**
  - 5%

- **New Flyer**
  - 45%
  - Battery and fuel cell electric bus options in existing platforms

Source: New Flyer, 2014
# Multiple Fleets Operating Zero Emission Buses in California

<table>
<thead>
<tr>
<th>Bus Fleet Operator</th>
<th>Technology Type</th>
<th>Zero Emission Buses</th>
<th>Existing Fleet Size</th>
<th>ZBus Percent of Fleet</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>In Service</td>
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<tr>
<td>Antelope Valley Transit</td>
<td>Battery</td>
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<td>Stanford University</td>
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<td>Anaheim Resort Transit</td>
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<tr>
<td>SunLine Transit</td>
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<td>Porterville Transit</td>
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<td>Foothill Transit</td>
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<td>Long Beach Transit</td>
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<td>UC Irvine</td>
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<td>1</td>
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<tr>
<td>ZEBA (AC Transit lead)</td>
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<tr>
<td>Monterey-Salinas</td>
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<tr>
<td>Los Angeles MTA</td>
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<tr>
<td>Total</td>
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<td>77</td>
<td>96</td>
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1 Source: 2014 ARB Reporting Database
How Do Costs Compare?

- Zero emission bus prices coming down
- Potential battery electric bus cost savings
  - Maintenance cost saving
  - Fuel cost saving with LCFS credits
- Fuel cell electric bus costs are declining but are still high in low volumes
- Low Carbon Fuel Standard lowers alternative fuel costs
- Other start-up costs with transition to new technology
- Continuing to refine cost details and collect data
Low Carbon Fuel Standard Program

- Fuel producers and importers must reduce carbon intensity of transportation fuels or must buy credits
  - Reduces GHG emissions
  - Reduces dependence on petroleum
- Transit fleets can generate credits
  - Dispense CNG, electricity, hydrogen into buses
  - Fixed guideway systems (rail, trolley bus, street car)
- Credits generated by alternative fuel producers
  - Reflected in renewable fuel price
  - Can share credits through contracts
### Total Cost of Ownership in the Same Ballpark

<table>
<thead>
<tr>
<th>Total Cost of Ownership (2016 Dollars, Thousands)</th>
<th>CNG Bus</th>
<th>Battery Electric Bus</th>
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<tbody>
<tr>
<td>Fuel <em>(net cost after LCFS credit)</em></td>
<td>$134</td>
<td>$36</td>
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<tr>
<td>Maintenance</td>
<td>$418</td>
<td>$298</td>
</tr>
<tr>
<td>Bus &amp; Installed Charger</td>
<td>$555</td>
<td>$790</td>
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</table>

**CNG Bus**
- 3.6 miles/gal on at $1.07/diesel gallon equivalent
- Maintenance is $0.85/mile + $35,000 mid life rebuild
- LCFS credit is typically received by fuel provider and already reflected in price when renewable diesel is used

**Battery Electric Bus**
- 2 kWh/mile at $0.15/kWh
- Maintenance is $0.66/mile reflects savings from manufacturer
- LCFS credit value of $100 (claimed by transit agency)
- 12 year battery warranty

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Note: Analysis period is 14 years at 40,000 miles/year for both buses and future costs adjusted to 2016 dollars.
California Supporting Transition to Advanced Technologies

- Zero Emission Bus Pilot Commercial Deployment Projects
  - Up to $65 million available (FY14/15) and (FY 15/16)*

- Hybrid and Zero Emission Voucher Incentive Project (HVIP)
  - $110,000 per vehicle

- Low Carbon Transit Operations Program
  - 5% continuous appropriation of annual Greenhouse Gas Reduction Fund (GGRF) proceeds

- Transit and Intercity Rail Capitol Program
  - 10% continuous appropriation of annual GGRF proceeds

* Portion of funds are pending authorization by the Legislature
Meeting Service Needs

- No reduced transit service as a result of the regulation
- Learning from transit fleets operating battery electric and fuel cell electric buses in revenue service
- Phased-in schedule to reduce operational risk and maximize the useful life of existing infrastructure
- Large deployments possible
  - Antelope Valley Transit already committed to 100% battery electric bus fleet by end of 2018
- Technology off-ramps to address operational concerns
Considerations for a Performance-Based Approach

- NOx/PM emissions in non-attainment areas
- Life cycle GHG emissions
- Surplus emission benefits outside of other regulatory programs
- Availability and best use of renewable fuels
- Impact of deterioration and high-emitters
Next Steps

- Continued engagement with stakeholders
  - Advanced Clean Transit Workgroup
  - Transit Agency Subcommittee
  - Electric Utility Workgroup
- Refine cost numbers and operational needs
- Additional outreach and education
  - How to generate and sell credits from LCFS program
- Workshops in spring and summer 2016
  - Technology and regulatory proposals
  - Economics and business case, funding and incentives
- Board consideration late 2016
Advanced Clean Transit Information

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Web page http://www.arb.ca.gov/msprog/bus/bus.htm