

# Zero Emission Bus Regulation Overview & Next Steps

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Workshop 2, MTC Oakland  
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## Agenda

Need for additional emission reductions

ZBus Regulation background

Summary of September 17, 2013 workshop

Discussion topics from stakeholder meetings

Further reductions possible

Next steps

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## Overall Emission Reduction Goals

- \* Significant emission reductions needed in heavy duty sector to meet long-term goals
- \* Achieving goals will require transformational change
- \* 90% reduction in NO<sub>x</sub> needed by 2032
- \* 80% reduction in GHG needed by 2050

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## Transit Fleets Lead The Way

- \* Significant reduction in PM and NO<sub>x</sub> already achieved from 2004 transit fleet baseline levels
- \* Half of California transit fleets already using CNG
- \* LA Metro and other agencies at 99% CNG
- \* SF Muni operates electric trolley fleet with commitment of 150 hybrid electric buses by 2014
- \* Zero Emission Bus demonstrations underway

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## Zero Emission Bus (ZBus) Regulation Background

ZBus Background

- \* Adopted in 2000 under Transit Fleet Rule
- \* Technology development
- \* Technology transfer to other heavy duty sectors
- \* Amended twice (2004, 2006)
- \* Purchase requirement on hold (2010 mailout, MSC 10-04)
- \* ZBus is a Battery Electric, Electric Trolley, or Fuel Cell Bus
- \* Fuel cell technology was the focus



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# Current Regulatory Elements

- \* Affects only large agencies
  - \* (>200 Urban Buses)
- \* ZBus Demonstrations
  - \* Diesel Path Only
  - \* Initial (2 demos, 2 TAs each, 3 buses) 2005-2007
  - \* Advanced ( 1 demo, 5 TAs, 12 buses, 2 fueling stations) 2010- current
- \* 15% ZBus purchase requirement (on hold MSC #10-04)
  - \* 2011 for Diesel Path Transit Agencies
  - \* 2012 for Alternative Path Transit Agencies

# Large Transit Agencies

Transit Agency	Total # Urban Buses	Fuel Path	15% of Avg. Annual Purchases
Los Angeles Metro	2651	CNG	33
San Francisco Muni	800	Diesel	0
Orange County Transportation Authority	626	CNG	8
Alameda-Contra Costa Transit	487	Diesel	6
San Diego MTS	465	CNG	6
Santa Clara Valley Transportation Authority	420	Diesel	5
Foothill Transit	300	CNG	4
San Mateo County Transit	293	Diesel	4
Sacramento Regional Transit	221	CNG	3
Long Beach Transit	218	Alternative Fuel	3
Golden Gate Transit	202	Diesel	3
Santa Monica Big Blue Bus	186	Alternative Fuel	0
Omnitrans	153	Alternative Fuel	0

Data from 2011

Total Annual Purchase = 74 Buses

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# First Workshop Technology Summit - Summary

Workshop Summary

- \* Principles of the regulation
- \* Technology Summit – Invited technology providers present feasible technology pathways
- \* Panel Discussions
  - \* Battery Electric Bus
  - \* Fuel Cell Electric Bus
  - \* ZBus Infrastructure
  - \* Real World Experience with ZBuses

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# Department of Energy Fuel Cell Electric Bus (FCEB) Targets

	2016 Target	Ultimate Target
FCEB Purchase Cost	\$1,000,000	\$600,000
Power Plant Cost	\$450,000	\$200,000
Power Plant Lifetime	18,000 hours	25,000 hours
MBRC <sup>1</sup> -Bus/ FC System	3,500 / 15,000 miles	4,000 / 20,000 miles
Bus Availability	85%	90%
Bus Maintenance	\$0.75/mile	\$0.40/ mile
Hydrogen storage	\$75,000	\$50,000

<sup>1</sup> Miles Between Road Calls

Bus Lifetime 12 years and 500,000 miles, Range of 300 miles/day, 7 days/week,  
Operation 20 hours/day, Fuel Economy 8 miles per diesel gallon equivalent

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## Panel 1: Battery Electric Buses (BEB)

- \* Panelists from BYD Motor, Proterra, Complete Coach Works, Ebus, and New Flyer
- \* Key Points from Panelists
  - \* Contracting similar to conventional buses
  - \* BEB capital costs lower than other ZBuses
  - \* Operation & Maintenance costs being collected
  - \* Third party evaluation by NREL estimates technology readiness level (TRL) at 6.
  - \* Performance needs to be similar to conventional buses (Availability, MBRC, Durability, Cost, etc.)



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## Panel 2: Fuel Cell Electric Buses



- \* Panelists from US Hybrid, Ballard Power Systems, BAE Systems, Hydrogenics, ABC Companies for VanHool, New Flyer
- \* Key Points from Panelists
  - \* Third party evaluation by NREL estimates technology readiness level (TRL) at 7
  - \* Need OEM production model
  - \* Need larger scale runs (~40)
  - \* Performance needs to be similar to conventional buses (Availability, MBRC, Durability, Cost, etc.)

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## Panel 3: ZBus Infrastructure

- \* Panelists from Protera, Eaton, Hydrogenics, Linde, Air Products, & Chemicals,
- \* Key Points from Panelists
  - \* Infrastructure size and type dependent on number of vehicles
  - \* Battery Electric Bus Infrastructure has several infrastructure options available
    - \* Fast Charge, Slow Charge Overnight, Inductive
  - \* Fuel Cell Infrastructure
    - \* Delivered, or produced onsite



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## Panel 4: Real World Experience with ZBuses



- \* Projects discussed BCTransit, San Joaquin Transit, Foothill Transit, SunLine Transit, SF Muni
- \* Key Points from panelists
  - \* Route and operational parameters guide choices
  - \* Choose ZBus technology type carefully & research options
  - \* Transit lead staff must champion the technology
  - \* Drivers & customers prefer over conventional buses
  - \* Performance & Cost needs to be similar to conventional buses (Availability, MBRC, Durability, Cost, etc.)

## ZBus Considerations

- \* Cost and availability
- \* Need for commercial scale production runs
- \* ZBus project data collection and public sharing
- \* Established bus OEM involvement
- \* Infrastructure

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# Individual Meetings with Stakeholders

ZBus Discussion

- \* Stakeholders
  - \* Large Transit Agencies (Urban Buses > 200)
  - \* Transitional Transit Agencies (Urban Buses 150-200)
  - \* Transit Agencies operating ZBuses
  - \* Fuel Cell Electric Bus Manufacturers
  - \* Battery Electric Bus Manufacturers
  - \* Infrastructure Manufacturers
  - \* Non Governmental Organizations

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## Commercialization of ZBuses

- \* What steps do we need to take before transitioning fleets to Zero Emission Buses?
  - \* Pilot scale production deployments
  - \* Zero Emission Bus
  - \* Zero Emission Miles with Combustion Hybrids
  - \* Timing
  - \* Transition mechanism

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## Pilot Scale Deployments

- \* Fuel Cell needs
  - \* 40 bus order – one platform
  - \* One site location to minimize infrastructure, maintenance, and training for operators and maintenance staff
  - \* (Example Center of Excellence - CaFCP Road Map for FCEB<sup>1</sup>)
- \* Battery Electric Bus
  - \* 6-8 bus order
  - \* One location to minimize infrastructure costs and maximize use

<sup>1</sup> <http://cafcp.org/carsandbuses/busroadmap>

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## Pilot Scale Deployments (Continued)

- \* Coordination of Transit Agencies
  - \* Maintenance
  - \* Operators
  - \* Purchasing
- \* What is needed for Fuel Cell Technology?
- \* What is needed for Battery Electric Bus Technology?
- \* What is needed for Trolley Technology?
- \* What are the commonalities?

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## Zero Emission Buses

- \* Based on zero tailpipe emissions
- \* ZBus is one of the following technologies or a combination of the technologies below:
  - \* Battery Electric
  - \* Electric Trolley
  - \* Fuel Cell Bus

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## Zero Emission Miles with Combustion Hybrids

ZBus Discussion

- \* Should we recognize zero emission miles?
- \* If so, how?
  - \* Percentage of miles/day?
  - \* Percentage of miles/route?
  - \* Total miles/day?
  - \* Miles between engine on?

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## Early Implementers

ZBus Discussion

- \* Should Transit Agencies be rewarded for acting early?
  - \* Regulated Transit Agencies
  - \* Non-regulated Transit Agencies
- \* Should Transit Agencies be rewarded for doing more than required?
- \* Should sharing between Transit Agencies be allowed?
  - \* If so, how?
    - \* Regional approaches?
    - \* Same air basin?
    - \* Operation and maintenance training requirements?

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## ZBus Purchase Requirement

- \* What should the trigger(s) be?
  - \* Performance
  - \* Incremental cost
  - \* Fixed Date
  - \* X months after start of pilot project

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## ZBus Purchase Requirement (Continued)

- \* Should the purchase requirement be phased in?
  - \* Purchase cycles
  - \* Fixed number
  - \* Percentage
- \* Optional provision to stagger initial ZBus purchase cycles at each transit by X years to allow incorporation into fleet.
- \* Should Zero Emission Miles be incorporated?

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Further Reductions

## Additional Reductions Achievable

- \* 2032 NO<sub>x</sub> and 2050 GHG emission reduction goals require transitional change
  - \* ZBus is a key element
- \* There may be other opportunities for additional NO<sub>x</sub>, PM, and GHG reduction goals

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# Discussion Ideas Further Reductions for Advanced Clean Transit

- \* Partner with Transit Agencies to take lead in meeting reduction goals
- \* Broaden scope to include all Transit Agencies
- \* Recognize actions already taken
- \* Continue long term zero emission bus commercialization
- \* Recognize zero emission miles and advanced technologies

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## Anticipated Timeline

- \* January – March 2014: Site Visits and Continued Conference Calls
- \* Late April / Early May 2014: Workshop
- \* May 2014: Board Update
- \* Summer 2014: Additional Workshops
- \* December 2014: Board Hearing

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## Third Workshop

- \* Late April/Early May 2014
- \* Advanced Clean Transit
  - \* Additional Fleet Reductions
  - \* Zero Emission Bus
    - \* Certification and Test Procedure
      - \* Zero Emission Technologies
      - \* Zero Emission Miles
    - \* Shape California's conceptual path(s) to commercialization
- \* Provide outline of draft regulatory approach
- \* Additional Stakeholder meetings as necessary

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# ZBus Announcements and Information

Next Steps

- \* ZBus Listserv
  - \* Future meeting information and notifications will announced
  - \* Please sign up on the Zero Emission Bus List Serv
    - \* [http://www.arb.ca.gov/listserv/listserv\\_ind.php?listname=zbus](http://www.arb.ca.gov/listserv/listserv_ind.php?listname=zbus)
- \* Zero Emission Bus website
  - \* Presentations
  - \* <http://www.arb.ca.gov/msprog/bus/zbus/zbus.htm>

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# Transit Announcements and Information

Next Steps

- \* Transit Listserv Notices
  - \* Future meeting information and notifications will announced
  - \* Please sign up for one of the list serv notices below:
    - \* 1) Transit Urban Bus
      - \* [http://www.arb.ca.gov/listserv/listserv\\_ind.php?listname=bus-ub](http://www.arb.ca.gov/listserv/listserv_ind.php?listname=bus-ub)
    - \* 2) Transit Fleet Vehicle
      - \* [http://www.arb.ca.gov/listserv/listserv\\_ind.php?listname=bus-tfv](http://www.arb.ca.gov/listserv/listserv_ind.php?listname=bus-tfv)
- \* Transit website
  - \* <http://www.arb.ca.gov/msprog/bus/bus.htm>

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## ZBus Contact Information

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## ZBus Displays or Rides

- \* AC Transit, Fuel Cell Electric Bus
- \* BYD, Battery Electric Bus
- \* Complete Coach Works, Battery Electric Bus