



FEDERAL TRANSIT ADMINISTRATION



Hydrogen & Fuel Cell Bus Initiative Paving the Way Nationally & Internationally

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Reason for Transit Interest



- ◆ Need to Meet Emissions Standards
- ◆ Reduce Operating Cost
 - Fuel efficiency – fuel is second largest operating cost
 - Current full size transit buses achieve only 3 - 4 mpg, less on some routes
 - Reduce maintenance costs
- ◆ Consumer Acceptance
 - Smoke and odor free
 - Clean and Quiet



Why Transit Buses



- ◆ Fleet Operations
 - Centrally fueled and maintained
 - Professional operators, mechanics, and fuelers
 - Urban stop-and-go duty cycle; fixed route & schedule
 - Less rigorous start-up & roll-out requirements
- ◆ Size and Weight of Vehicle
- ◆ Federal Support for Capital Purchases
 - Federal funding support
 - Programs to assist introduction of new technologies
- ◆ High Visibility/High Impact
 - Operate in densely populated areas
 - Broader public exposure and acceptance



Initiative Vision



Quiet, Zero-Emission, Fuel Efficient
Buses Are in Revenue Service
Throughout the Nation



Initiative Goal



By 2015, 10% of New U.S. Bus
Purchases Will Be Fuel Cell Buses



Initiative Elements



- I. Transit Bus RD&D
 - Vehicle Systems
 - Enabling Technologies
- II. Transit Hydrogen Infrastructure
 - Demonstrations
 - Facility Guidelines
- III. Education & Outreach
 - Information Sharing
 - Public Education
 - Workforce Training



I. Transit Bus RD&D – Vehicle Systems



1. Heavy-Duty Fuel Cell Bus

2. Automotive Based Fuel Cell Hybrid Bus



3. Hydrogen Internal Combustion Engine (ICE) Hybrid Bus



1. Heavy-Duty Fuel Cell Bus



Characteristics

- 200 – 300 kW fuel cell for all power required
- No batteries
- 40-ft. heavy-duty transit bus platform
- 12-year useful vehicle life
- High current cost



Heavy-Duty Fuel Cell Bus Activities



- ◆ Data Collection & Evaluation of Demonstrations Planned & Underway
- ◆ Establish Future Fuel Cell Bus Parameters & Technical Targets
- ◆ RD&D with Multiple Teams





2. Automotive Based Fuel Cell Hybrid Bus



Characteristics

- 25 – 75 kW fuel cell for average power required
- Batteries for peak power and regenerative braking
- 30-ft. transit bus platform
- 7-10 year useful life
- Moderate current cost





Automotive Based Fuel Cell Hybrid Bus Activities



◆ RD&D with Multiple Teams

➤ Model I Automotive Based Fuel Cell Hybrid Bus

- Ballard, DaimlerChrysler
 - University of Alabama Birmingham
 - EPA, UPS Delivery van
- UTC Fuel Cells, ISE Research
 - ThunderPower fuel cell hybrid bus
 - New Haven, EBus
- Hydrogenics, Enova
 - Hickam Air Force Base

➤ Model II Light-duty Fuel Cell Hybrid Bus

◆ Baseline Data Collection & Evaluation



3. Hydrogen Internal Combustion Engine (ICE) Hybrid Bus



Characteristics

- Hydrogen ICE generator for electrical power
- Batteries to supplement electrical power and for regenerative braking
- 40-ft. or 30-ft. transit bus platform
- Useful life contingent on vehicle platform 7-12 years
- Low cost – accelerate hydrogen infrastructure





Hydrogen ICE Bus Activities



◆ Demonstrations

➤ Hydrogen ICE Hybrid Bus

- SunLine Transit, SCAQMD, Ford, New Flyer
- AC Transit, Van Hool Bus, WestStart-CALSTART

➤ Hydrogen/Natural Gas Blend ICE Bus

- UC Davis, Unitrans

◆ Data Collection & Evaluation

- ### ➤ Establish baseline for hydrogen ICE and hydrogen/natural gas blend ICE buses



International Fuel Cell Bus Workshop



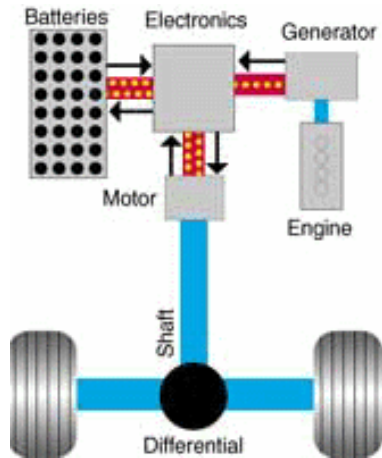
- ◆ FTA led with the American Public Transportation Association, the Electric Drive Transportation Association, & DOE
- ◆ Information sharing on status of fuel cell bus demonstrations underway & planned
- ◆ Harmonize data collection and evaluation plans for demonstrations underway & planned
- ◆ Facilitate collaboration and coordination for RD&D of future fuel cell buses
- ◆ Launch International Fuel Cell Bus Working Group



I. Transit Bus RD&D – Enabling Technologies



Electric Drive



Lightweight Bus



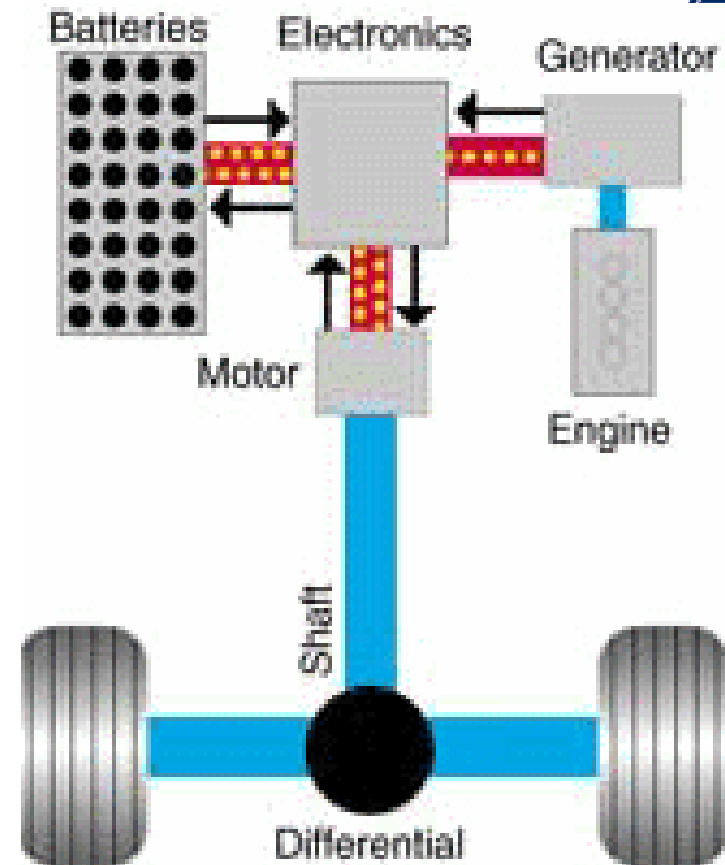


Enabling Technologies – Electric Drive



Key component for fuel cell buses

- ◆ Energy storage options
 - Batteries
 - Ultracapacitors
 - Flywheels
- ◆ Power electronics & control
- ◆ Electrically driven accessories





Electric Drive Activities



- ◆ Energy Storage RD&D
 - Nickel hydrogen battery – Pioneer Valley Transit, ElectraStor
 - Flywheel – WestStart-CALSTART, AFS Trinity
 - Ultracapacitor – Electric Fuel, GE
- ◆ Power Electronics & Control
 - Advanced power electronics & control systems for fuel cell and hybrid buses
- ◆ Electrically Driven Accessories
 - HVAC Systems



Enabling Technologies – Lightweight Bus



Goals

- ◆ Reduce propulsion power requirements

- ◆ Bus weight reduction
 - Structure
 - Components





Lightweight Bus Activities



- ◆ Bus Structure Weight Reduction RD&D
 - Reduce weight of transit bus structures by $>1/3$
 - Leverage earmarks & DOE effort
- ◆ Bus Component RD&D
 - Optimize weight reduction of transit bus components
 - Leverage earmarks



II. Transit Hydrogen Infrastructure



Early Demos and Deployment

- ◆ Coordinate and collaborate with DOE
- ◆ Safely demonstrate
 - Early hydrogen refueling
 - Shared use of refueling facilities





Transit Hydrogen Infrastructure Activities



- ◆ Hydrogen Refueling Demonstrations
 - Hydrogen refueling at transit agencies with shared public use
 - Collaborative effort with DOE, EPA & international programs
- ◆ Transit Facility Guidelines
 - Update guidelines for the safe use of hydrogen
 - Collaborative effort with Volpe



III. Education & Outreach



FTA leadership role in the
RD&D of hydrogen fuel
cell buses

- ◆ Information sharing
- ◆ Public education and outreach
- ◆ Training





Education & Outreach Activities



◆ Information Sharing

- Publicize role of hydrogen & fuel cell buses
- Collaborate with APTA, industry associations, and researchers
- US Fuel Cell Bus Working Group
- International Fuel Cell Bus Working Group

◆ Public Education on Benefits & Safety of Hydrogen Fuel Cells

- Use fuel cell buses to provide greater exposure to the general public
- Collaborate with DOE, EPA, State, Regional, local governments, & international effort

◆ Training

- Develop appropriate training programs for transit operators and maintenance personnel