FEDERAL TRANSIT ADMINISTRATION

Hybrid Electric Vehicle Projects

Transit Research And Technology Programs

- **Strategic goals**
  - Promote public health and safety by eliminating injuries and death
  - Shape an accessible, reliable and integrated transportation system that offers choices
  - Sustain America's economic growth
  - Protect and enhance communities and the natural environment
  - Ensure security of the transportation system
  - Advance our ability to manage for results and innovation

Federal Transit Administration (FTA) Research and Technology Programs

- **Focus on the development and deployment of technological innovations to:**
  - **improve personal mobility**
  - **minimize fuel consumption and air pollution**
  - **increase ridership**
  - **enhance the quality of life for all communities**

Federal Transit Administration (FTA) Research and Technology Programs

- Programs areas are focused around:
  - bus
  - rail
  - safety
- Current programs are:
  - Congressionally directed
  - Earmarks are managed to best fit strategic objectives of FTA

FTA Budget Reflects Increased Interest in Clean Fuel Technology Vehicles

- Transit has been at the forefront of implementing alternative fuels and advanced propulsion technologies
- Increasing interest in clean fuel technology vehicles for transit vehicles evidence in both the research and capital budgets

Motivation to Adopt Clean Fuels and Technologies

- Energy security and air quality concerns
- Legislation (CAAA, EPACT, AMFA)
- Tightening emissions standards
- Local pressure
- Possibility of lower fuel and maintenance costs

Transit Operator Concerns

- Providing mobility
- Operating costs
- Reliability
- Maintainability
- Safety
- Air quality and environmental impacts

Vehicle technology must not impair o[illegible]
provide effective, cost efficient, and saf[illegible]

Why Transit Continues to Use Clean Fuels?

- Highly visible
- Perception of transit as polluter
- Large centralized fleet
- Federally subsidized fleet
- Local pressure (decision locally controlled)
- Continued pressure to further lower emissions standards for buses

Clean Fuels in Transit

- Experience with these technologies vary greatly from agency to agency
- Increasing amount of local and federal funds spent on clean fuel technologies
- Transit industry is recognizing the importance of accurate information on clean fuel vehicles such as their cost, performance and reliability in operation, in assessing clean fuel vehicle options

Bus Research and Technology Current and Planned Programs

- Fuel cell bus development and testing
- Hybrid electric bus technologies
- Advanced battery bus demonstration program
- Bus Testing Program
- Electric bus recharging technologies
- Electric and hybrid electric bus data

FTA Fuel Cell Transit Bus Program

Congressionally mandated program with Georgetown University to demonstrate viability of fuel cell power plants for transit bus applications

- **Budget: $4.8M per year for FY1999-FY2003**
- **Milestones:**
- **40-foot Phosphoric Acid Fuel Cell (PAFC) transit bus rolled-out in May 1998**
  - Hybrid-electric configuration with 100 kW fuel cell and 85 amp-hr battery
  - World's first liquid-fueled fuel cell powered transit bus
- **40-foot PEM Fuel Cell Transit Bus rolled out February 2000**
  - 100 kW PEM fuel cell fabricated by dbb fuel cell engine corp. (Ballard) and delivered to NovaBUS
  - Uses methanol reformer technology from automotive program

FTA Fuel Cell Transit Bus Program Activities

- Memorandum of Agreement executed between FTA and Georgetown University
- Under agreement, six additional transit buses using fuel cells from two manufacturers to be developed, demonstrated and evaluated
- Hybrid configuration with possibility of non-hybrid 200 kW fuel cell propulsion systems
- Funds not sufficient to cover multi-year effort, Georgetown working to secure additional funds from transit agency or other government partners (e.g., CTA and NAC)
- Cost shortfall exacerbated by price of fuel cell stack greater than originally anticipated
- Transit Review Committee established for industry input

New York Hybrid Bus

- Orion VI platform
- GE wheel motors and inverters
- 100 kW diesel engine generator
- 100 kW flooded NiCad batteries
- Prototype for 5 new hybrids

DUETS - New York Hybrid Bus

- Started FY 94 as TRP project
- Fiber optics
- Semi-active suspension system
- Continued in the FTA FY 99 R&D budget
- Prototype for 5 NovaBUS hybrids for NYC Transit
- Completed EMI testing

DUETS: Phase II

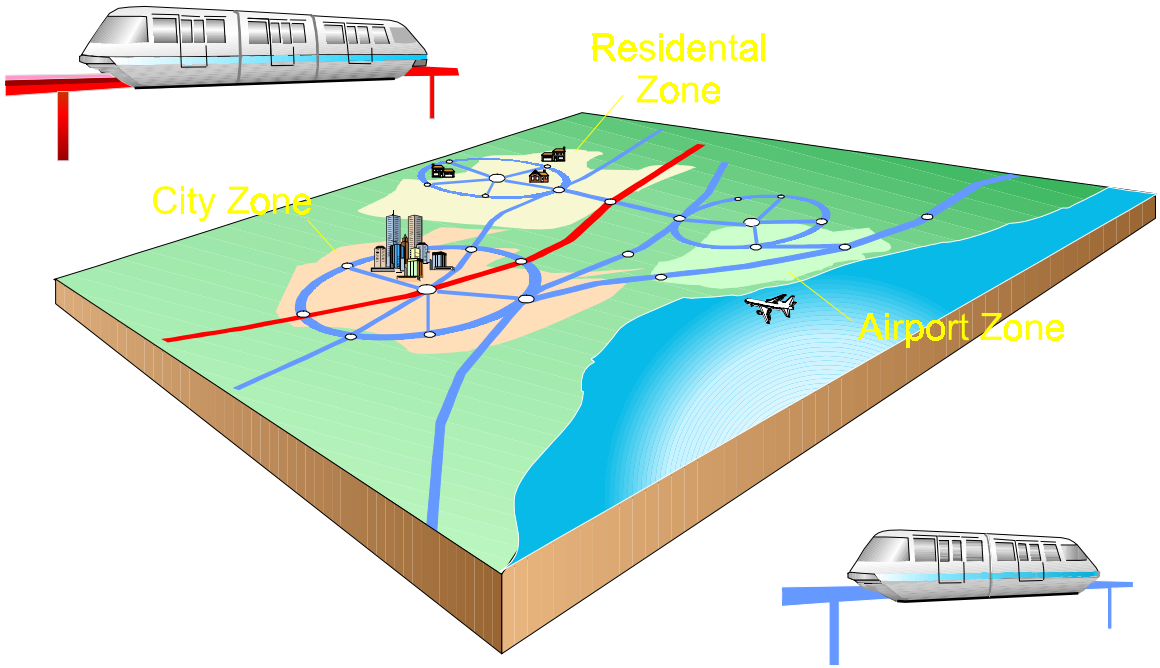
- **Participants**
  - Cooperative agreement with NovaBUS, Davis Technologies, and Honeywell Consortium
- **Budget**
  - Phase II funding from FY1998 earmark of $1.0M
  - Phase I and II are 50/50 cost share with industry
- **Schedule and Milestones**
  - Testing complete Q1, 2000
  - Final reporting complete Q2, 2000

DUETS: Current Status

- Revenue testing in New York City complete
- Emissions tests complete -- results are promising
- Semiactive suspension systems integrated onto vehicle, nominal tests complete
- Problem with drive system resolved, possible technical implications for other TRI bus programs being explored
- Performance testing and evaluation continues
- New York City Transit plans to acquiring five hybrid buses similar to the DUETS design, with potential for large hybrid bus acquisition

FTA Low Speed Maglev Program

Concept of an Integrated Maglev Network



- **Current procurement**
- **Ease congestion**
- **Clean, quiet**
- **Lower R.O.W. & guideway costs**
- **Multimodal**

Advanced Technology Transit Bus

- **“Stealth” Bus**
- **LACMTA and Northrop Grumman**
- **10,000 lbs. lighter than conventional**
- **Modular CNG engine**
- **Adaptable to other propulsion technologies**

ATTB Development Effort Complete

Development and testing program, began in 1992 with LACMTA, to develop a lightweight, low floor, low emissions transit bus and to provide the results to the transit industry

- **Six prototypes developed and build by Northrop Grumman Corporation**
  - 40-foot full low floor bus, composite vehicle structure, electric drive system, compressed natural gas (CNG) engine
- **Prototypes underwent extensive testing**
- **Testing revealed proof of basic design concepts and uncovered shortcomings**
- **Prototype disposition issues unresolved**
- **Final independent assessment not funded**

ATTB Follow-on Effort Continues

Program to adapt, integrate and test three vehicle subsystems on an ATTB prototype

- **Participants**
  - Houston METRO, Univ. Of Texas-Center for Electromechanics
- **Budget**
  - 1992 grant to Houston METRO for $4,488,000
- **Current Status**
  - ATTB shipped to Houston, now at UT-CEM
  - UT-CEM contracted with PMI to provide control system and integration for vehicle
  - Wheel motors and suspension system ready for integration

ATTB Follow-on Effort with Houston

- **Schedule and Milestones**
  - Wheel motors and suspension system integration complete - Q4, 2000
  - Flywheel and energy storage integration and checkout complete Q2, 2001
  - Test plan implementation Q2-Q4, 2001

ATTB and Other Advanced Buses Feature Low Floor Designs

- **Kneeling front end**
- **Simple ramp replaces entry steps**
- **Reduced cost and maintenance over wheel chair lifts**

Zinc Air Battery Bus Demonstration Program

Program to demonstrate proof-of -concept of Zinc air battery technology for 40-foot transit bus application

- **Participants**
  - Cooperative agreement with Electric Fuel Corporation, CST, and RTC of Clark County, NV with subcontract to GE
- **Budget**
  - Phase I funding from FY 1998
    - Federal share $ with 50/50 cost share coop agreement
  - FY1999 and FY2000 earmarks for follow-on
- **Schedule and Milestones**
  - Propulsion design complete
  - First technical peer review meeting held August 1999
  - System integration/ testing complete Q2, 2000
  - Final report, Q2/Q3, 2000

Zinc Air Battery Bus Demonstration Program

- Phase II
  - $1.5M in FY1999 earmark for Phase II follow-on effort
  - Recently met with a Electric Fuel Corporation to discuss Phase II effort scope and structure
  - Outstanding issues include SOW, partner cost share, structure of Phase II effort
  - Phase II proposed work includes battery and vehilce testing, infrastructure study, and ultracapacitor integration
  - Earmark in FY2000 budget ($988,492)
  - *Status: EFC will consult with current and potential new project participants, and will submit a revised proposal for the phase II effort*

New and Planned Efforts

New efforts are Congressionally mandated in FY 1999 and FY 2000 appropriations

- **MBTA advanced electric buses and related infrastructure**
- **Palm Springs, CA fuel cell bus program**
- **Santa Barbara Transportation Institute**
- **EVAA and EPRI information sharing and technology transfer**
- **Pittsfield electric bus program**
- **CALSTART -- new effort**
- **Advanced bus technology programs earmarked in capital program**

New and Planned Efforts

- **MBTA advanced electric buses and related infrastructure**
  - Inductive roadway, opportunity charging technology demonstration for electric vehicles
  - FY1999 earmark $1.5M and $1,482,739 in FY 2000
- **Palm Springs fuel cell buses**
  - Sunline project for demo of direct hydrogen fuel cell bus
  - FY1999 earmark $1.0M, and $988,492 in FY2000
- **Santa Barbara Transportation Institute**
  - Electric vehicle program focused on electric bus operation and technologies; rapid charging
  - Structured as cooperative agreement, with some cost share
  - $494,246 earmark in FY2000

New and Planned Efforts (cont'd)

- **EVAA and EPRI information sharing and technology transfer**
  - New effort on electric vehicle information sharing and technology transfer
  - FY2000 earmark for $741,369
  - FTA recently held initial meeting with Electric Vehicle Association of the Americas (EVAA) to discuss scope

New and Planned Efforts (cont'd)

- **Pittsfield electric bus program**
- Project to fund development effort to fabricate a prototype 30-foot, composite, low-floor, all electric transit bus with rapid recharge
- Electric Vehicles World Wide (EVWW) plans to establish an electric bus manufacturing facility at a former GE manufacturing plant in Pittsfield to manufacture vehicle
- FY2000 earmark of $ 1,134,465
- Focus on continued development and commercialization of Ergenics segmented nickel - hydrogen battery

New and Planned Efforts (cont'd)

- **CALSTART**
  - Program focused on advanced transportation demonstrations of station cars and mobility program
  - Effort not follow-on to current activities
  - Cooperative agreement with cost share
  - $3,212,600 in FY2001 earmark