# Harmonization and Sharing of Data from International Fuel Cell Bus Demonstrations

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# Outline

- Overall Working Group Goals
- Challenges
- Workshop Summary
- Data Collection/Sharing
- Example Data from U.S.
  - Santa Clara VTA, San Jose, CA

# Overall Goals

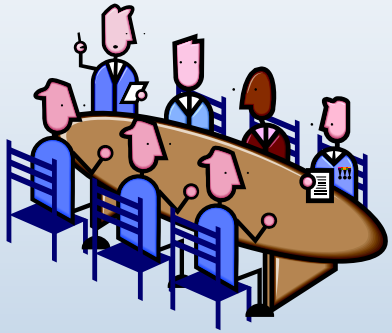
In 2003, the U.S. Federal Transit Administration began an effort to form a Fuel Cell Bus (FCB) Work Group.

The goals of the group were to:

- Enhance information sharing on the status of FCB demonstrations worldwide
- Harmonize data collection and evaluation to maximize possible learnings
- Facilitate coordination and collaboration of research, development, and demonstration of future FCBs

# Challenges

- Gaining participation from “appropriate” people:
  - Representatives involved with demonstration/data collection
  - Authority to commit to sharing data
  - Availability/willingness to attend workshops



- Solutions:
  - Hold workshops in conjunction with events likely to draw “appropriate” people
  - Invitations to specific individuals involved in demos
  - Establish diverse organizing committee (FTA joined by EU in planning and funding)
  - Rotate locations of workshops to cover multiple countries

# Challenges

- Consensus on data collection:
  - Building common data element list
  - Addressing challenges from many country perspectives

- Solutions:
  - Develop multiple levels of data sharing:
    - High level data – non-sensitive data that can be made publicly available (Phase I and II)
    - More detailed data – potentially sensitive data shared with work group participants only
  - Begin constructing list by comparing common data items already being collected
  - Involve all work group participants in decision process

# Challenges

- Gaining agreement to share data:
  - Involvement from all demonstrations/teams
  - Willingness to share information that will further advance the technology and not let marketing get ahead of the true status

- Solutions:
  - Begin with collecting the Phase I, high level data to build trust between participants
  - Work as a group to develop the strategy for collecting and sharing data

# Workshops

1st Workshop: Long Beach, California, USA

Nov. 19 – 20, 2003

Associated event: EVS 20

2nd Workshop: Porto, Portugal

Nov. 18 – 20, 2004

Associated event: CUTE project meeting


3rd Workshop: Vancouver, BC, Canada

Dec. 4 – 6, 2005

Associated event:

EDTA Conference

4th Workshop: Yokohama, Japan

Oct 21 - 13, 2006

Associated event: EVS 22

# Data Collection/Sharing

- Established three levels of data:

| Phase I | Phase II |
|---|---|
| High Level | Medium Level |
| Non-sensitive | Somewhat sensitive |
| General information on project, operating fleet, buses, infrastructure | **Bus data:** Fuel consumption, availability, reliability, maintenance **Infrastructure data:** fueling rates, efficiency, availability, maintenance |
| Will be shared | Will be shared |
| Status: Data collection in progress | Status: Finalizing list of data |

| Detailed Data |
|---|
| Proprietary |
| Detailed voltage and current data on the FC and systems |
| Will not be shared |

# DOE/NREL FCB Evaluation Results

## Santa Clara VTA

- 3 prototype FCBs: Gillig buses with Ballard FC system (non-hybrid)
- Diesel buses for baseline comparison

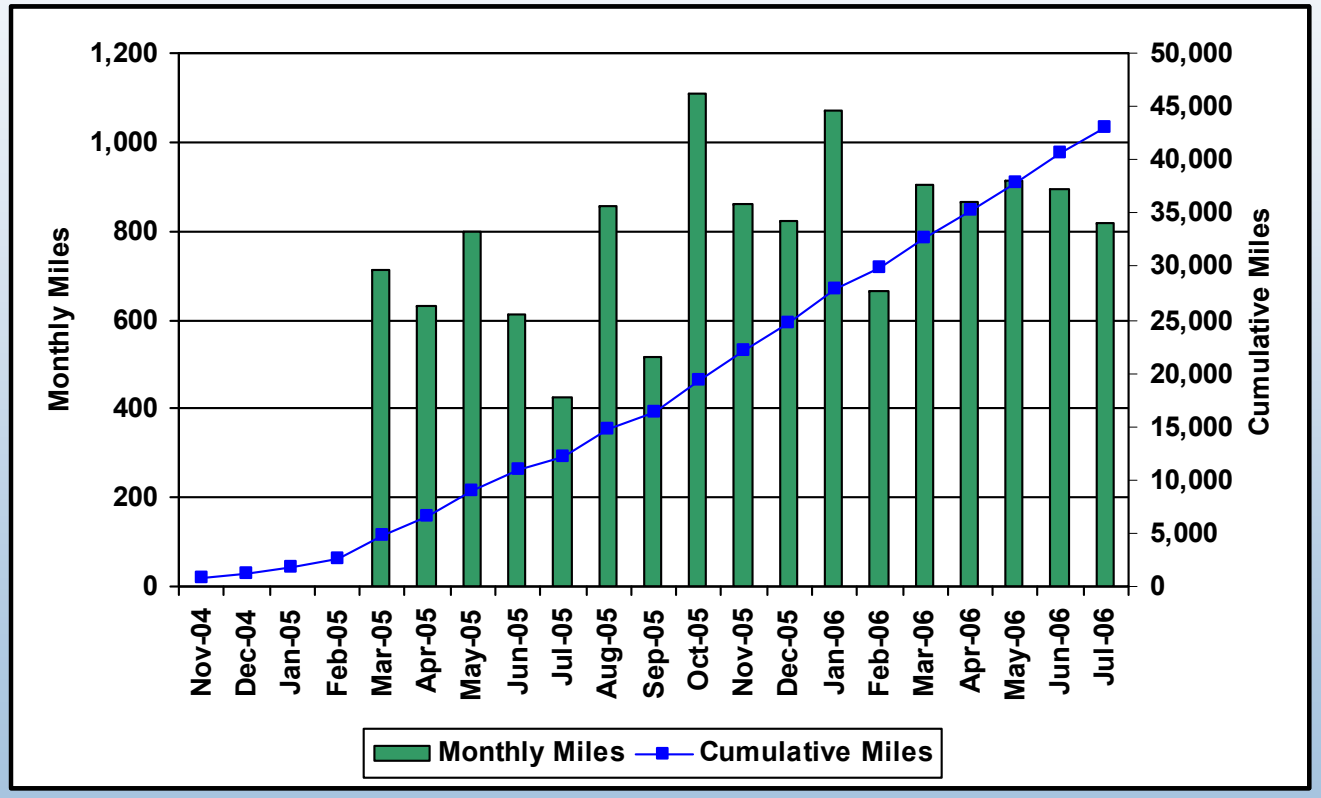

Diesel Bus


Fuel Cell Bus

| Vehicle System | Cerone Depot | |
|---|---|---|
| | Fuel Cell Buses | Diesel Buses |
| Number of Buses | Three | Five |
| Bus Manufacturer and Model | Gillig low-floor | Gillig low-floor |
| Model Year | 2004 | 2002 |
| Length/Width/Height | 40 feet/102 in/144 in | 40 feet/102 in/120 in |
| GVWR/Curb Weight | 40,600 lb/34,100 lb | 39,600 lb/27,300 lb |
| Wheelbase | 284 in | 284 in |
| Passenger Capacity | 37 seated or 29 seated and two wheelchairs, five standing | 38 seated or 31 seated and two wheelchairs, 43 standing |
| Engine Manufacturer and Model | Two Ballard fuel cell modules P5-2 | Cummins ISL (8.9 liter) |
| Rated Power | 150 kW each (300 kW total) | 280 bhp @ 2,200 rpm |
| Rated Torque | 790 lb-ft @ 1,350 rpm (1250 Nm) | 900 lb-ft @ 1,300 rpm |
| Accessories | Mechanical | Mechanical |
| Emissions Equipment | None | Diesel oxidation catalyst |
| Fuel Capacity | Approx. 55 kg hydrogen at 5,000 psi | 115 gallons |

# FCB Usage

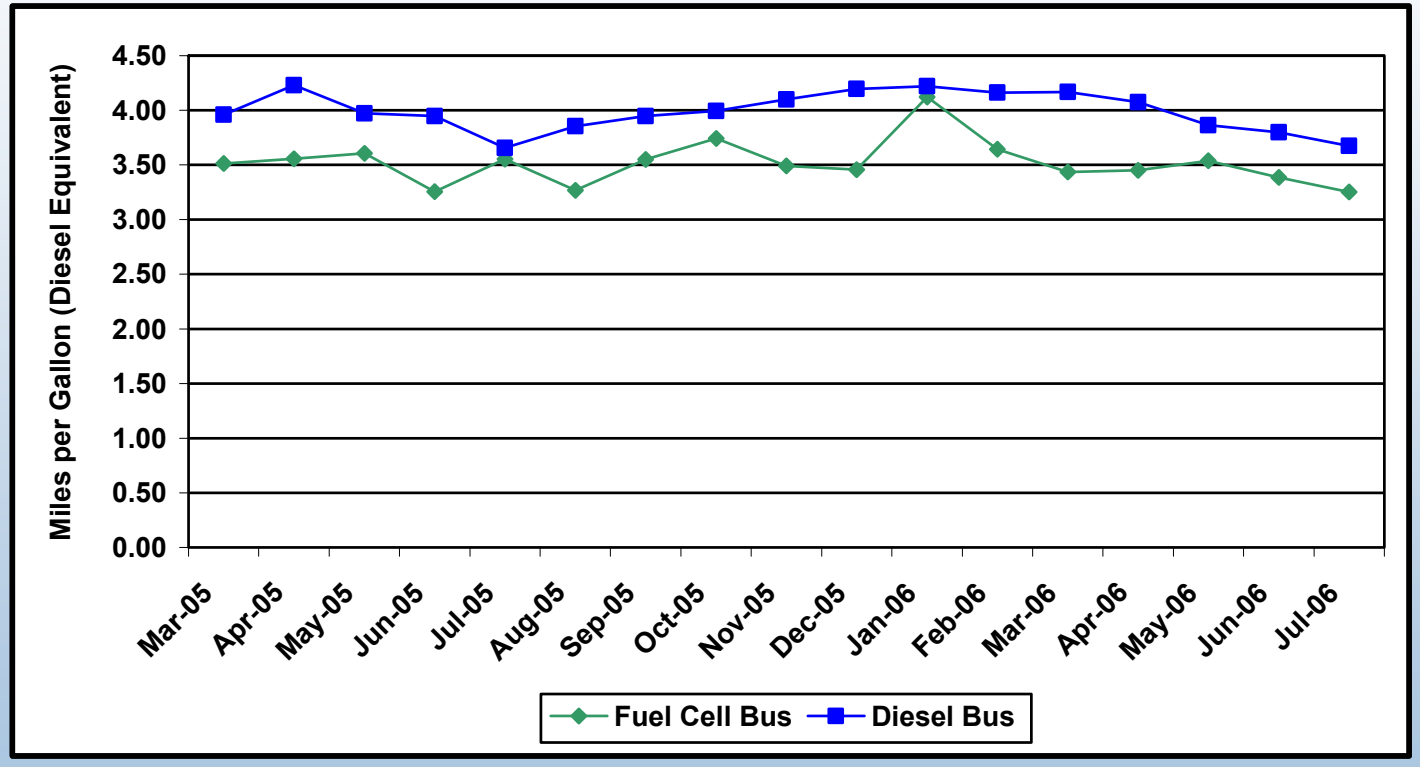
## Cumulative and monthly mileage on VTA FCBs




- 40,000 total fleet miles
- 3,219 total FC hours
- All 3 buses over 1,000 hours
- Average monthly mileage/FCB: 809 mi

# Fuel Economy

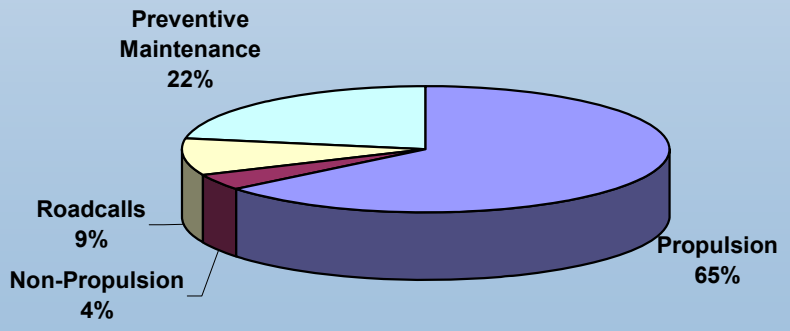
## Average Fuel Economy for FCBs and Diesel Controls




Fuel economy for the FCBs averaged 3.12 mi/kg; 3.52 mi/diesel equivalent gallon vs. 3.98 mpg for the diesel control buses (-12%)

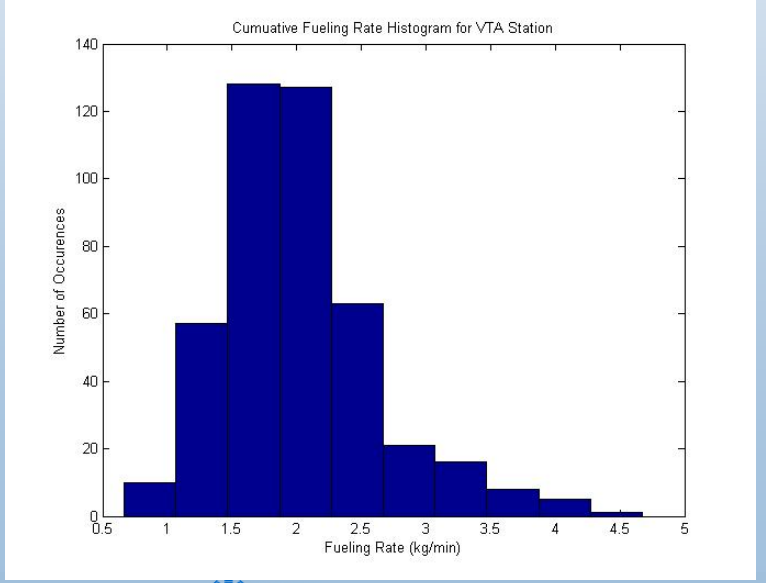
# Availability

- Availability
  - Planned use of the FCB:
    - 2 of the 3 buses in service each weekday except for holidays
    - Extra service (between regularly scheduled buses)
  - Goal for FCBs: 67% availability
  - Actual availability during evaluation period: 58%
  - Diesel buses: 85%
  - Breakdown:



# Infrastructure

- Infrastructure
  - Liquid $H_2$ delivery and storage
  - Station availability: 99%
- Fueling Rates for the year in kg/min
  - 460 bus fills
  - Rate Max 4.67, Min 0.66
  - Avg Rate 1.93
  - Avg fill amt: 30.9 kg

# Acknowledgements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# Questions

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