National Renewable Energy Laboratory
Innovation for Our Energy Future

NREL & DOE Activities: Update

HTUF 2009

Fleet Experience and Needs Session

Kevin Walkowicz

National Renewable Energy Laboratory
Advanced Vehicle Testing Activity

October 28, 2009

NREL/PR-540-46995

MD & HD Hybrid Fleet Testing at NREL

- **Funded Through DOE's Vehicle Technology Program**
- **Goals/Objectives:**
  - Real-world feedback: new technology vs conventional (under same conditions)
  - 6-12 month, on-road evaluations
  - Obtain and analyze data:
    - Operating cost/mile
    - Fuel economy
    - Maintenance costs
    - Warranty issues
    - Reliability (miles between failure)
    - Implementation issues from a fleet's perspective
    - Duty cycle analysis
    - Subsystem performance
  - Provide data to help fleets, manufacturers and other R&D organizations who might be considering similar technology
    - Publish data
    - Acquire data for vehicle modeling activities
    - Identifies additional barriers to energy efficient vehicles

Recent Projects: Fed Ex (DOE, CALSTART, SCAQMD)

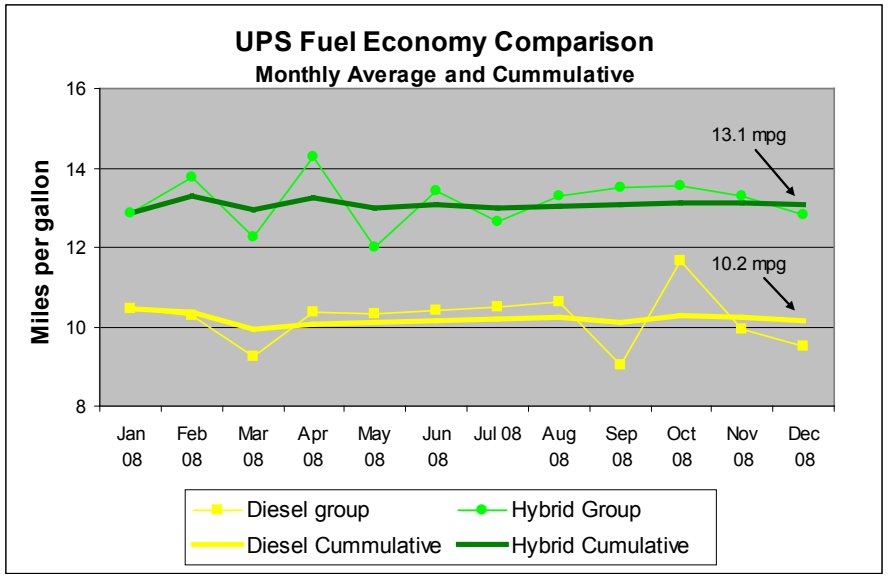
- Azure HEV Delivery Vehicles
  - **Status:** Dyno testing and on-road evaluation - April 2009 thru April 2010
  - **Technology:** Azure Gen I gasoline HEV in Southern CA vs conventional diesels
  - **Data:** Interim report in late 2009, Final report in mid 2010; Include both on-road and chassis dyno data
  - **Results:**

    Chassis Dyno Data:
    - MPG: -2 to +20 % improvement in MPG (dge) (gasoline engine vs diesel)
    - Emission Reductions:
      - Much cleaner!
      - NOx = 75-89%
      - PM = 99.9%

HTUF4	10.45	11.36	11.66	-2.6%
OCTA Bus	8.61	9.36	9.52	-1.7%
NYCC	6.75	7.34	6.08	+20.7%

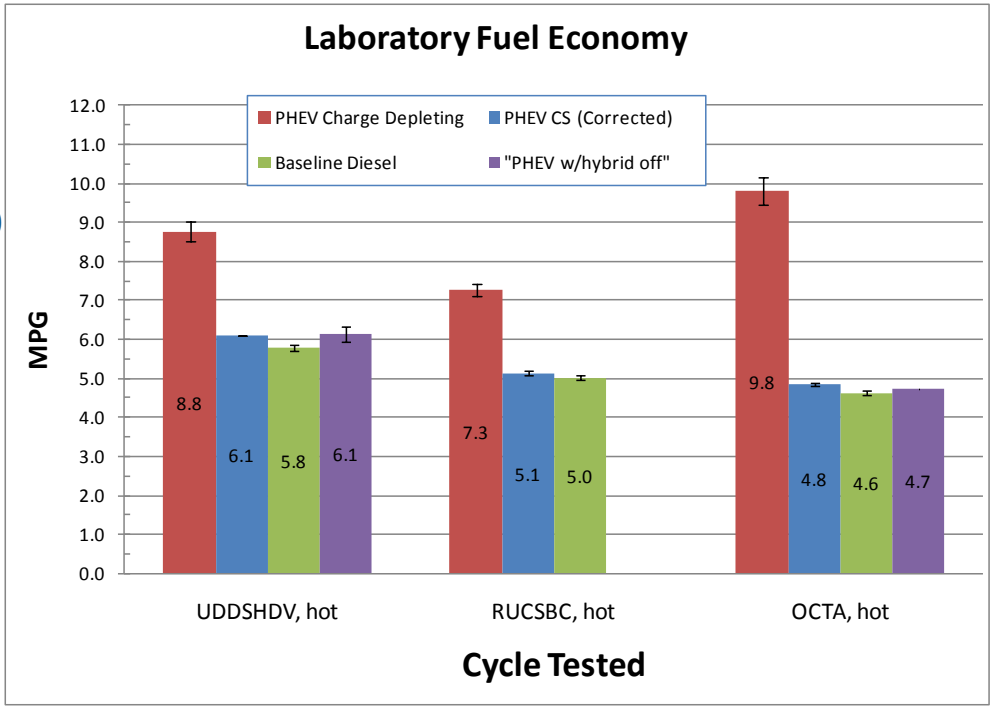
Recent Projects: UPS

- Eaton Hybrid Delivery Vehicles
  - **Status:** Dyno testing and on-road evaluation began in 2008. Now complete.
  - **Technology:** Gen I diesel HEV in-use in Phoenix, AZ vs conventional diesels
  - **Data:** Final report in Nov 2009 will include on-road eval + chassis dyno data
  - **Results**:
    - 29% on-road fuel economy improvement for hybrids
    - 31-37% improvement in-lab (CILCC/CBD/WVU City)
    - Diesel = $0.53 per mile operating costs
    - Hybrid = $0.43 per mile operating costs



Recent Projects: PHEV School Bus

- PHEV School Bus / Enova-IC Corp
  - **Status:** Dyno testing and on-road evaluation completed for 4 sites (Austin, Napa, Wake County NC, Manatee FL)
  - **Technology:** Diesel Plug-In HEV (Enova charge-depleting) school buses in-use in various locations
  - **Data:** Final report in Dec 2009
  - **Results**:
    - 44-113% improvement in CD
    - But…3-39 miles possible in CD
    - Slight improvement in CS
    - On-road MPG:
      - 6.5-7.1 mpg diesels
      - 8.0-9.1 mpg hybrids
    - Good reliability and low maintenance costs



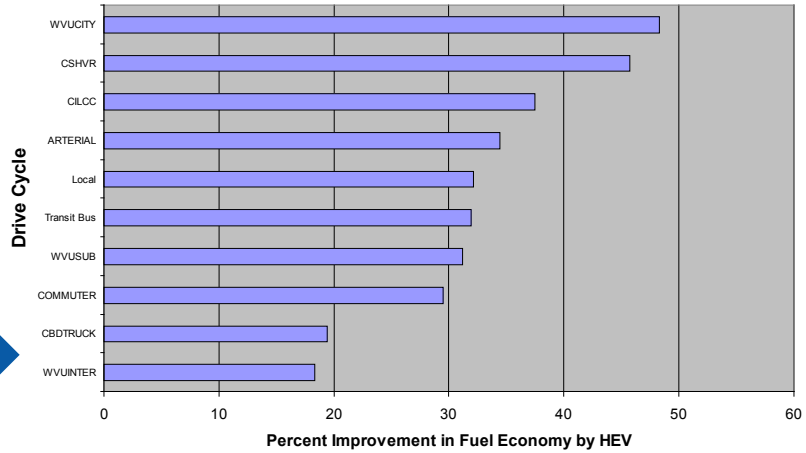
FY10 Planned Projects: More Hybrids!

- Recently announced DOE funded grants (still under negotiation):
  - Navistar: Expanded, next-gen PHEV school bus
  - SCAQMD: 378 trucks and shuttle buses with Eaton
  - Navistar: 400 EV Delivery Trucks
  - Smith Electric: ~100 Transit Connect EV and 'Newton' MD trucks

- FY10 Evaluations and Interests (being planned now thru DOE's Vehicle Technologies Program):
  - Class 7-8 HEV
  - Day Cab HEV tractors
  - Lithium battery buses - various locations, in-depth battery data
  - Next generation, improved HEV systems for MD Package Delivery
  - Plug In Hybrid Trucks
  - Hydraulic Hybrids

Key Findings & Considerations

- Business Case and Payback?
  - Duty Cycle drives fuel use and % improvement
  - The ‘most urban’ route not always best place for HEV’s and other advanced technology vehicles
  - Fuel Price Driven



- Green Initiatives?
  - CO2 Credits / Cap & Trade

- Future of Hybrids – Market Penetration?
  - Depends on Fuel Prices, hardware costs (battery costs), incentives

For More DOE / NREL MD&HD Hybrid Info

Lee Slezak
U.S. Dept of Energy
Vehicle Technology Analysis & Evaluation Program Manager
Vehicle Technologies Program
Lee.slezak@ee.doe.gov
202-586-2335

Kevin Walkowicz
National Renewable Energy Laboratory
Advanced Vehicle Testing Activity Team Lead
kevin.walkowicz@nrel.gov
phone: 303.275.4492