PLUG-IN HYBRID ELECTRIC MEDIUM DUTY COMMERCIAL FLEET DEMONSTRATION AND EVALUATION

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June 9, 2010

ARRAVT068

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Overview

Timeline
- Start – November 2009
- Finish – August 2013
- 10% Complete

Budget
Total project funding
- DOE - $45,443,325
- Contractor - $45,612,649

Barriers
- EV mode implementation
- Component reliability
- Sub-system interfaces
- Engine integration
- Emissions system impacts
- System/vehicle validation and certifications
- Wide distribution of demonstration fleet vehicles
- Quick deployment timeline

Partners
- SCAQMD
- EPRI
- Eaton
- Altec
- SCE
- A123
- Ford
Objectives

- Nationwide demonstration and evaluation of 378 medium-duty PHEVs
- Develop a production ready PHEV system for class 4 – 5 vehicles
- Develop production ready “smart charging” capability for the vehicle
- Build customer familiarity
- Quantify performance attributes and environmental impact
- Use project results for system development to optimize performance and reduce costs
Approach – F550 Utility Truck

- **Vehicle Design**
  - Eaton Hybrid 6 speed Automatic-Manual Transmission
  - Ford 6.7L Diesel Engine
  - High Energy Lithium-Ion Battery (13 to 15 kWh)
  - Blended Regenerative Braking
  - Engine Off at Zero Speed
  - On-board Charger (>3.3 kW)
  - Charging-Level 1 (120 Vac) and Level 2 (240 Vac)
  - Electrified Accessories (Steering, Brakes, and HVAC)
  - Export Power (5 kW, 120 Vac, 60 Hz)

- **Performance Specifications:**
  - ePTO operation (>5 Hours with Engine-Off)
  - Up to 10 miles pure electric range (30 mph average)
  - Up to 300 miles range between refills
  - Charge time less than 6 hours with Level 2
  - FMVSS compliant
Approach – E450 Shuttle Bus

- **Vehicle Design:**
  - Azure Hybrid System
  - Ford 5.4L Gasoline Engine
  - High Energy Lithium-Ion Battery (13 to 15 kWh)
  - Blended Regenerative Braking
  - Engine Off at Zero Speed
  - On-board Charger (3.3 kW)
  - Charging-Level 1 (120 Vac) and Level 2 (240 Vac)
  - Electrified Accessories (Steering, Brakes, and HVAC)

- **Performance Specifications:**
  - Up to 10 miles pure electric range (~25 mph average)
  - Up to 300 miles range between refills
  - Charge time less than 6 hours with Level 2
  - FMVSS compliant
Technical Accomplishments

- **Specifications**
  - Specification Project Scope –90% complete
  - Vehicle Specification –95% complete
  - System Specification –90% complete
  - Vehicle weight distribution –complete
  - Charging sequence strategy –50% complete
  - SAE J1772 interface investigation

- **Ford**
  - Ford is fully engaged and supportive
  - 2 Engineering vehicles were delivered to Eaton (model year 2011 uses a new 6.7L diesel engine)
  - Working with Ford on logistics, safety and validation
  - First 20 units scheduled at Ford
Technical Accomplishments

- **Component Development**
  - Component Development Supplier Selection –75% complete
  - Eaton received first battery and motor
  - Body design / PHEV space claim complete
  - Clutch Development –kicked off
  - Flywheel and flywheel housing development –kicked off
  - Motor FEAs complete to investigate transmission housing stress

- **System feasibility study**
  - Structural analysis complete
  - Base vehicle performance testing –complete (MY 2011 vehicle testing)
  - Packaging analysis -complete
  - MP2 vehicle received –will be sent to Altec for upfitting
  - Ran tests on redundant approach for e-accessories
Collaborations/Partnerships

- SCAQMD – Prime Recipient
- California Energy Commission – Funding Partner
- EPRI – Program Management and Fleet Coordinator
- Eaton – Hybrid System Developer
- Altec – Body Builder & PHEV Integrator
- So Cal Edison – Battery and Vehicle Testing
- A123 Systems – Battery Supplier
- Ford – Chassis Supplier & Integration Support
Future Work

- **Fiscal Year 2010**
  - Finalize the specification for the base vehicle with the individual fleet operators
  - Complete clutch and flywheel design
  - Initiate system validation testing
  - Initiate the build of the base vehicles ahead of the delivery of the hybrid drive system
- **After 2010**
  - Complete system validation testing
  - Install 240V vehicle charging infrastructure
  - Install plug-in hybrid drive systems on the base vehicles
  - Install cellular based data acquisition systems and set-up download servers to acquire in-use performance data
  - Deliver 378 PHEV to fleet operators
  - Evaluate and analyze the vehicle operation in the field
  - Conduct laboratory emissions and fuel economy tests
  - Conduct battery cycle life testing
  - Conduct user surveys
The project will:
- Quantify the attributes of a medium-duty PHEV for shuttle bus and utility truck vocations in terms of:
  - Criteria pollutant emissions
  - Greenhouse gas reductions
  - Fossil fuel displacement
- Further optimize the efficiency of the system based on data that is collected in the field
- Create a path to commercialization for a medium-duty PHEV system

The design specifications are nearly complete to enable an EV capable medium-duty PHEV that can operate accessories electrically at a job site and drive electrically.

Fleet participants have been engaged to enable a nationwide demonstration program of 378 vehicles.

Major component suppliers have been selected for:
- Traction motor
- Traction battery
- Flywheel and clutch
- Electric power steering/brake pump
- Electric AC compressor