Medium-Duty Vehicle Projects

Jeff Cox – Air Quality Specialist
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Medium-Duty Vehicle Projects

• EPA - Series Hydraulic Hybrid
• Calstart - Parallel Hydraulic Hybrid
• EPRI - 378 Vehicle Fleet of PHEV’s
EPA Series Hydraulic Hybrid Shuttle bus

- Vehicle Technology
  - EPA Series Hydraulic Drivetrain
  - HCCI Engine
  - Navistar IC Bus Chassis
  - Demonstrate in a Shuttle Bus Application
Shuttle Bus Project Development Path

1. Develop HCCI Engine
2. Install HH Drivetrain on Chassis with a 6.4L Diesel Engine
3. Calibrate HH Drivetrain
4. Install HCCI Engine in IC Bus Chassis with HH Drivetrain

Steps:
- Development Series Hydraulic Hybrid Drivetrain
- Install HCCI Engine in IC Bus Chassis with HH Drivetrain
Drive Cycle Characteristics

**EPA City Cycle Bag 1** Connector urban traffic, high speed highway link, average speed = 25.6 mph, 5 stops

**EPA City Cycle Bag 2** Business district/residential urban traffic, average speed = 15.3 mph, 13 stops

**Manhattan Bus Cycle** Congested urban bus route, average speed = 6.8 mph, 24 stops

**Denver Bus Cycle** Congested urban shuttle route, average speed = 4.5 mph, 28 stops
Series HHV Initial Evaluation

- **UDDS (Bag 1)**: 34%
- **UDDS (Bag 2)**: 79%
- **Manhattan Bus**: 151%
- **Denver Bus**: 220%

Fuel Economy (mpg)
Series Hydraulic Hybrid
Steady State Fuel Economy

![Graph showing fuel economy improvements for Series HYBRID compared to a Stock Truck. The graph indicates a net improvement of 10-25% better.]
Eaton/ Calstart Parallel Hydraulic Hybrid

• Vehicle Technology
  – Eaton Parallel Hybrid Hydraulic Drive System
  – Ford 5.4L Gasoline Engine
  – Ford E450 Chassis
  – Demonstrated in a Shuttle Bus Application
Parallel Hydraulic Hybrid Development Pathway

1. Develop Parallel System for Refuse Application
2. Develop Parallel System for Shuttle Bus Applications
3. Integrate Parallel System into an E450 Shuttle Bus
## Comparative Test Results

### Parallel Hydraulic Hybrid

<table>
<thead>
<tr>
<th>Vehicle Weight</th>
<th>HC</th>
<th>PM</th>
<th>NOx</th>
<th>CO</th>
<th>Fuel Economy (mpg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>64,000 lbs</td>
<td>3%</td>
<td>8%</td>
<td>12%</td>
<td>35%</td>
<td>20%</td>
</tr>
</tbody>
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**Peterbilt 28.5 Ton GVW**

- 315 hp engine
- 5-speed automatic transmission
- 30 meters between stops
- 1000 stops per day
Vehicle Description

- F550 & E450 Chassis Options
- Ford 6.7L diesel and 5.4L gasoline engine options
- 13 – 15 kWh Li-Ion battery pack
- Regenerative braking
- Engine-off at zero speed
- All-electric operation at low speeds
- All-electric jobsite operation
PHEV Utility Truck Operation

- Engine-Off ePTO at 2 different job sites (Charge Depletion)
- Driving back to home base (Charge Depletion)
  Operator flips switch - or Automated Detection

Driving
(Charge Sustain at initial SOC)
PHEV Project Objectives

• 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 vehicle
• Build customer familiarity
• Use project results for further system refinement
Project Schedule

- Start Program (December 2009)
- Volume Production Build Complete (June 2011)
- 1st Vehicle Delivered (December 2010)
- Fleet Evaluation Complete (Aug 2013)