Medium and Heavy Duty Vehicle and Engine Testing

2010 DOE Hydrogen Program and Vehicle Technologies Program Annual Merit Review and Peer Evaluation Meeting

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Overview

Timeline

Start date: FY02
End date: on going
Percent complete: on going

Barriers

Hardware Maintenance
Data Acquisition Upgrades
Changing Emissions Regulations

Budget

Each project funded independently through DOE R&D programs or work for others projects

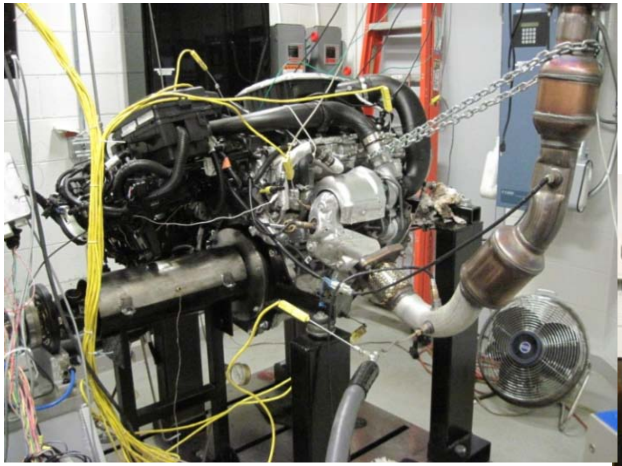
Partners

DOE Vehicle Technologies Program and work for others partners

Objectives

Operate and maintain a medium-duty and heavy-duty vehicle and engine dynamometer test facility for evaluating the performance, fuel economy, and emissions impacts of bio-fuels and electric and hybrid electric powertrains.

ReFUEL Laboratory



Approach - Chassis Dynamometer Test Cell

Test Range: 8,000–80,000 lb (Class 3-8)
- Twin 40” rolls (adjustable wheelbase)
- 380 hp DC motor

Features
- Programmable driver’s aid
- Electrical / mechanical inertia simulation
- Augmented braking
- Grade simulation
- Automated warm-up & coast-downs

Data Acquisition
- Regulated emissions measurement for 2010 HD on-road engine technology (2007 CFR)
- High accuracy (+/- 0.5% reading) fuel metering

Approach - DC Engine Dynamometer Test Cell

DC Dynamometer (400 hp/300kw)

- Transient federal test procedure (FTP)
- Programmable steady state modal testing

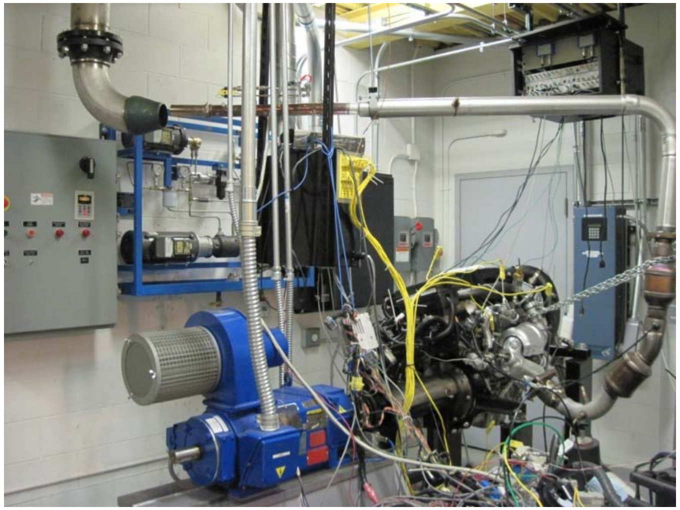
Data Acquisition

- High accuracy fuel metering
- 24 channel high speed combustion analysis (in-cylinder pressure, needle lift)

Air Handling

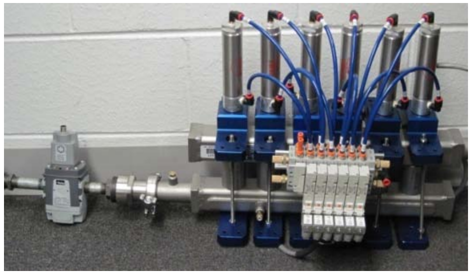
- Meets 2010 HD on-road requirement (2007 CFR, including part 1065)
- Metered, conditioned intake and dilution air
- Flexible full-scale CVS system
- Altitude simulation (sea level to mile high)
- Air handling system capable of sea level transient operation

Approach - AC Engine Dynamometer Test Cell



AC Dynamometer (75 hp/ 56 kW)
- Programmable steady state testing
- Dynamometer speed up to 6500 rpm

Dynamometer Control and Data Acquisition
- Sakor dynamometer controller
- Drivven engine controller (provides flexible engine control)
- AVL IndiModul high speed DAQ and combustion analysis



Fuel and Air Handling
- High accuracy critical orifice system for air flow control and measurement
- Customer designed high pressure fuel handling system providing fuel pressure up to 6000 psi, compatible for any bio-fuels

Approach- On-Road Emissions Measurement

- Portable Emissions Measurement System (PEMS)
- Continuous Measurement of CO, NO, NO_2, THC, CO_2 & O_2
- Ambient temperature, relative humidity, global positioning satellite (GPS) receiver, vehicle interface

Approach - Emissions Measurement

Continuous gaseous regulated emissions measurement
- Horiba Mexa 7000 Emissions Bench
- Sensors-SEMTECH mobile emission analyzer
- CAI emission bench
- Pierburg emission bench

Non-regulated emissions measurement
- Fourier Transform Infrared (FT-IR) spectrometer
  - Unregulated HCs and aldehydes emissions measurement
- TSI Fast Mobility Particle Sizer (FMPS)
  - 5.6 to 560 nm particles
  - Continuous sampling up to 1Hz
  - Heated dilution system
- DNPH Cartridges Sampling and HPLC Analysis
  - Aldehydes/ Ketone
- 2010 level gravimetric PM measurement

Approach – Fuel Storage, Blending and PM Measurement

Fuel storage (48 drum) and blending

Clean room for sample handling, storage, and gravimetric PM measurement

Other fuel and emission analysis equipments available -- GC-MS, IQT, HPLC

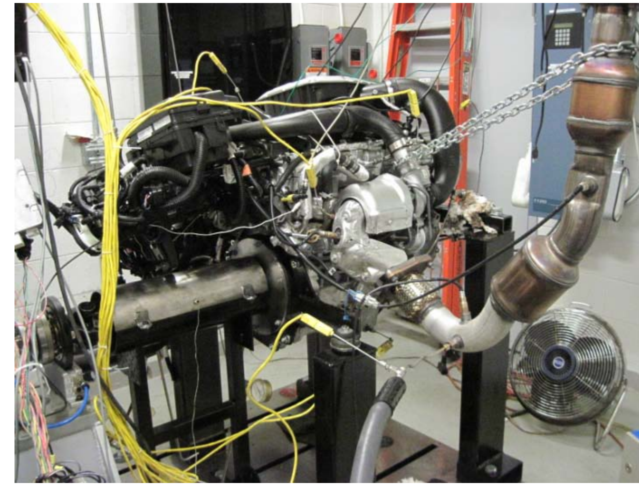
Accomplishments - Single Cylinder SIDI Engine Set-up

Engine Geometry

- Converted from GM LNF SIDI engine
- 86 × 86 mm, 9.2 CR--Higher CR pistons available

Fully Designed for Bio-fuels and Advanced Combustion Study

- P and T measurement and control
  - Spark plug and cylinder head integrated pressure transducer
  - Intake, exhaust, and fuel rail pressure measurement with Kistler transducers
  - Independent intake air, engine oil and coolant temperature control
- Fuel cart- 6000 psi
  - Compatible with any bio-fuels
- Drivven engine controller
  - Flexible fuel injection timing, spark timing, fuel pressure, and cam-phaser control
- Dedicated critical orifice air flow system
  - Accurate air flow measurement and control



Accomplishment - Evaluated Emissions and Fuel Consumption Test Results from a Plug-In Hybrid Electric (PHEV) School Bus

HEVs add a disconnect between engine and vehicle operation

PHEVs add two more complexities

- Fuel and electricity consumption
- Performance dependence on distance

Buses tested in this study
(both 72 passenger, DPF equipped)

Baseline conventional: 2008 Bluebird

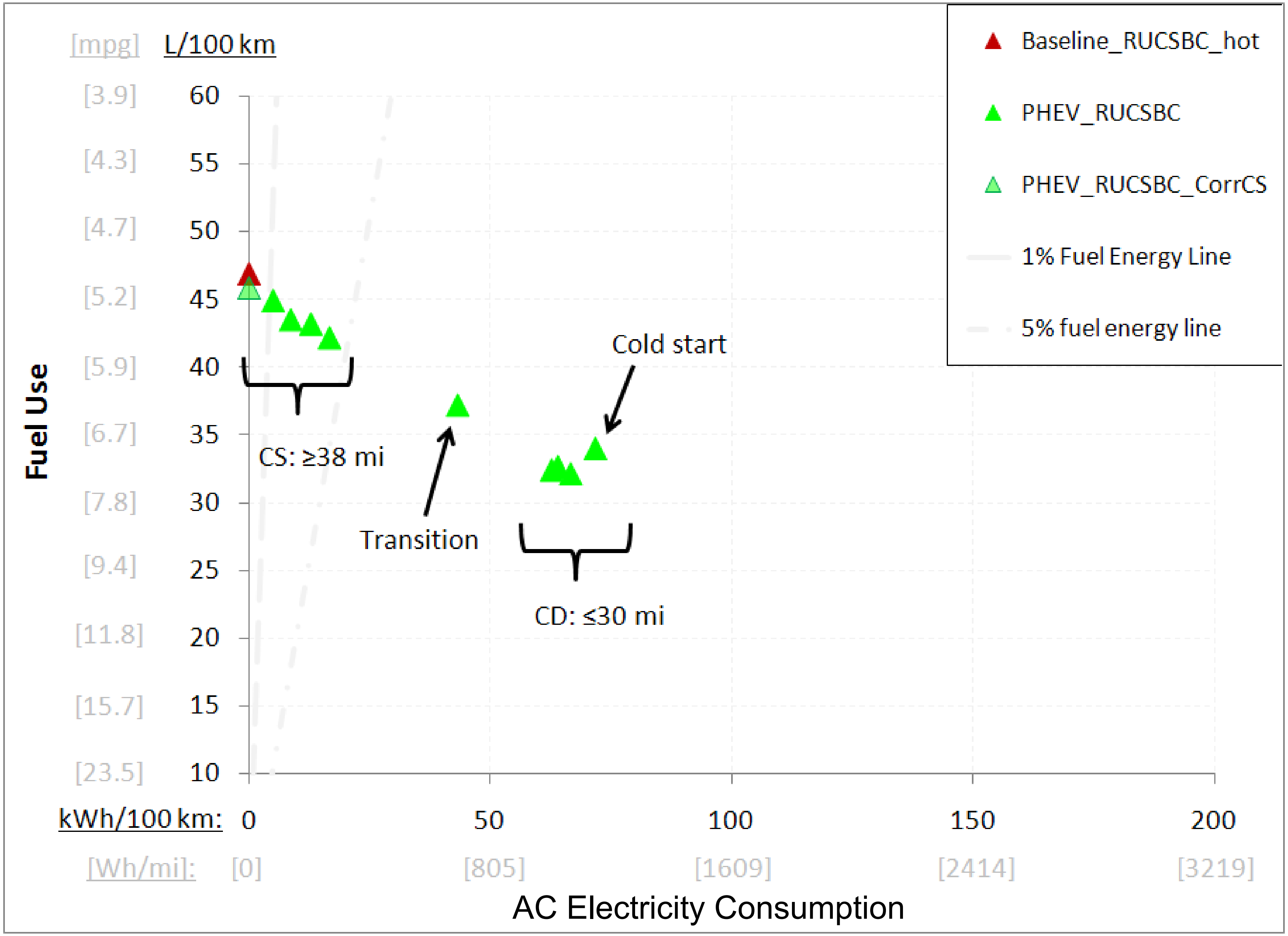
- 7.2 L Caterpillar Engine: 261 kW (350 hp)
- Test mass: 24,550 lbs

PHEV: 2007 IC Corp./Enova

- 6.4 L MAXXFORCE Engine: 149 kW (200 hp)
- Electric induction motor: 25/80 kW (cont./peak)
- 370 V Li-ion battery pack
- Test mass: 27,850 lbs

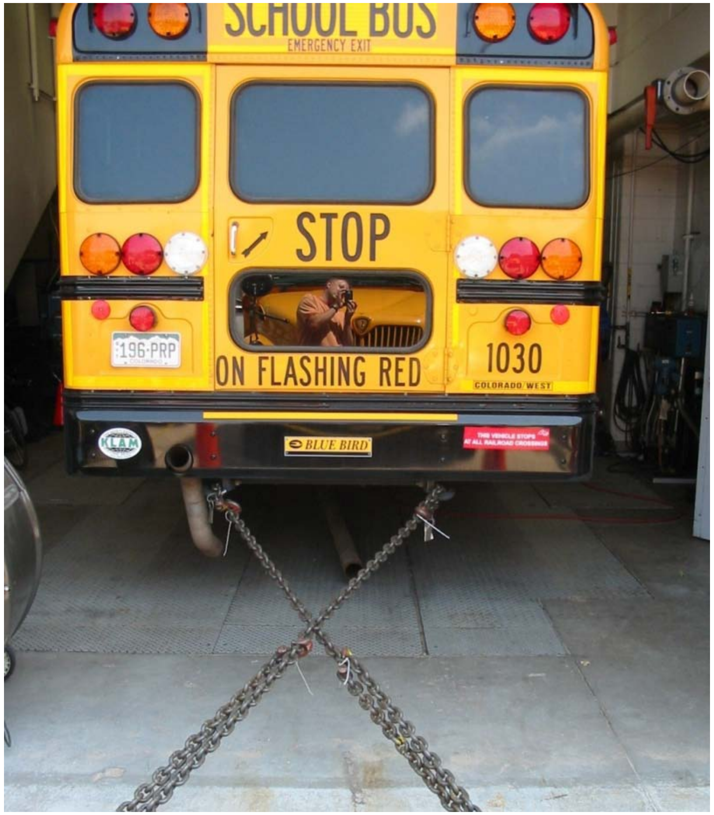
HEV = Hybrid electric vehicle; PHEV = Plug-in HEV

Accomplishments – PHEV School Bus Test Results, School Bus Cycle (RUCSBC)



Accomplishments – PHEV School Bus Testing Conclusions

- PHEV technology can save a significant amount of fuel
  - Savings magnitude depends on both **driving type** and **distance between charging**
- Low PM emissions for diesel particulate filter (DPF)-equipped busses (≤0.01 g/mi)
- Improvement opportunities for tested PHEV school bus for fuel and emissions benefit
  - Implement a lower-NOx engine calibration
  - Improve CS (HEV) mode implementation (further reduce Knox and fuel use)

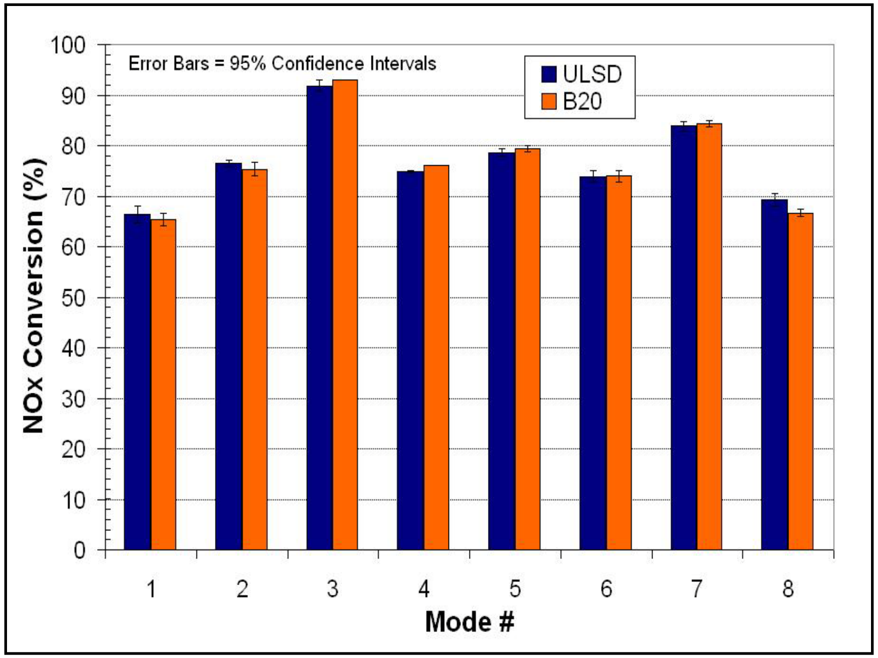


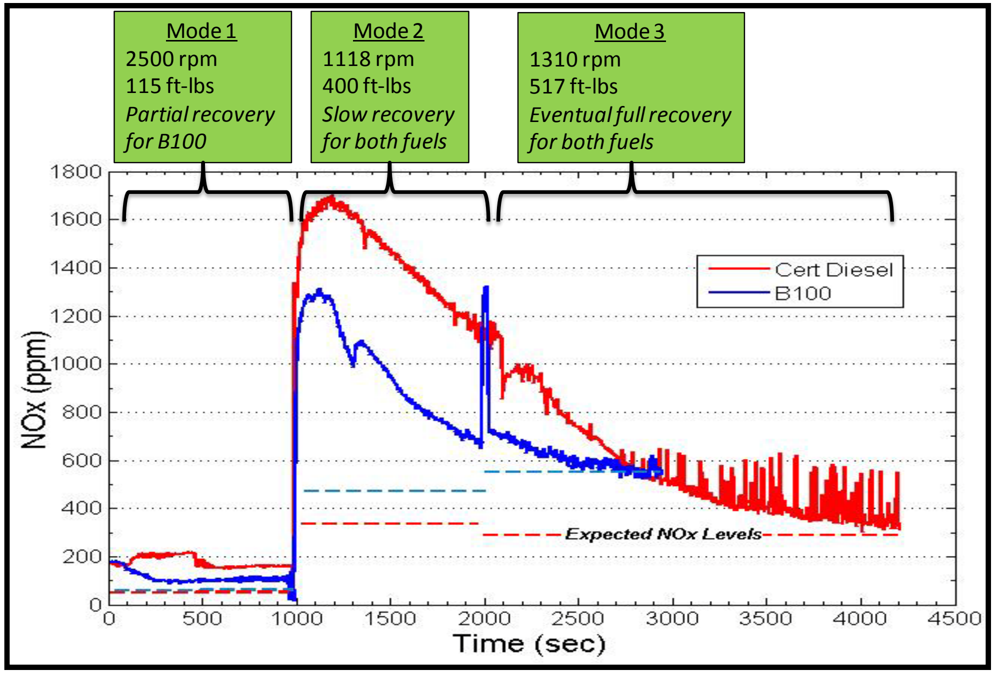
Accomplishments - Evaluated Urea SCR System on ISB Engine

Retrofitted 2002 ISB with Fe-zeolite SCR

Measure Knox reduction of system with ULSD and B20

No difference in Knox reduction performance of B20





Significantly less HC inhibition for B100

– Lower engine out HC emissions

– Quicker recovery to steady-state Knox conversion after increasing temperature

Summary

Approach:

- Chassis dynamometer
- DC engine dynamometer
- AC engine dynamometer
- On-road emissions Measurement
- Emissions Measurement
- Fuel storage and blending

Accomplishments:

- Single cylinder SIDI engine set-up
- Evaluated Emissions and Fuel Consumption Test Results from a Plug-In Hybrid Electric (PHEV) School Bus
- Evaluated Urea SCR System on ISB