Driving R&D for The Next Generation Work Truck

NTEA Green Truck Summit

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Today’s Discussion

• NREL’s Medium- and Heavy-Duty Truck RD&D

• Highlights:
  Improved Energy and Operational Efficiency

• What’s Next?

• Ongoing Live Polling
NREL’s
Medium- and Heavy-Duty Truck RD&D
Have you ever partnered with NREL or another national lab?

A. Yes

B. No
NREL is the only national laboratory dedicated solely to energy efficiency and renewable energy.
Which of the following technology breakthroughs did NREL innovation help bring to market?

A. Solar Cells  
B. HEVs  
C. LED Lighting  
D. All of the Above
• Clean-energy innovation for 35 years
• ~1,700 employees
• World-class facilities
• Living model of sustainable energy
• Owned by the Department of Energy
• Operated by the Alliance for Sustainable Energy
NREL Transportation Research

Photos by Dennis Schroeder, NREL
Flagship Transportation Capabilities

Vehicle Thermal Management
- Integrated Thermal Management
- Climate Control / Idle Reduction
- Advanced HVAC

Vehicle Deployment / Clean Cities
- Guidance & Information for Fleet Decision Makers & Policy Makers
- Technical Assistance
- Online Data, Tools, Analysis

Regulatory Support
- EPA Compliance
- Data & Policy Analysis
- Technical Integration
- Fleet Assistance

Infrastructure
- Vehicle-to-Grid Integration
- Integration with Renewables
- Charging Equipment & Controls
- Fuelling Stations & Equipment
- Roadway Electrification
- Automation

Combustion / Fuels
- Advanced Petroleum and Biofuels
- Combustion / Emissions Measurements
- Vehicle and Engine Testing

Vehicle and Fleet Testing
- MD/HD Dynamometer Testing
- MDV and HDV Testing / Analysis
- Drive Cycle Analysis / Field Evaluations
- Technology Performance Comparisons
- Data Collection, Storage, & Analysis
- Analysis & Optimization Tools

Power Electronics and Electric Motors
- Thermal Management
- Thermal Stress and Reliability

Battery & Fuel Cell Energy Storage
- Development, Testing, Analysis
- Thermal Characterization/Management
- Life/Abuse Testing/Modelling
- Computer-Aided Engineering
- Electrode Material Development

Illustration by Josh Bauer, NREL
Many Partners in Wide Range of Sectors

Illustration by Josh Bauer, NREL
Highlights: Improved Energy and Operational Efficiency for Medium- and Heavy-Duty Trucks
NREL Medium- & Heavy-Duty Vehicle RD&D

NREL provides core RD&D for medium- and heavy-duty fleets through:

• MDV and HDV analysis and testing
• Field evaluations
• Performance data collection and analysis
• Experimental evaluation and virtual modeling and simulation
• Guidance and information for fleet decision makers and policy makers
• Stimulation and expansion of markets
• Forums for collaboration
• Technical expertise
• Online tools and data
• Regulatory guidance.
At what distance did NREL find the most fuel savings between two trucks traveling at 65 mph?

A. 20 feet  
B. 40 feet  
C. 50 feet  
D. 75 feet
Validating Fuel Savings from Connected Vehicles

Class 8 Truck Platooning
- On-track testing and evaluation of platooning impact on fuel efficiency and emissions
- Class 8 line-haul trucks
- Combined “team” fuel savings from 3.7% to 6.4%

Partners: Intertek, Peloton

Connected Vehicle Technology for Trucks
Vehicle platooning
Driving analysis and behavior
“Green” routing and adaptive control
What percentage of long-haul truck fuel is used for rest-period idling?

A. 6.8%
B. 2.3%
C. 15.1%
D. 0.8%
Assessing Impact of Heavy-Duty Vehicle Thermal Management

High Efficiency Configurations Lower AC Demands by >36%

- 667 million gallons of diesel fuel used annually for long-haul truck rest period idling
- More than a 36% reduction in A/C loads using high efficiency configuration included ultra-white paint, advanced insulation, advanced curtains
- More than a 20% reduction in A/C load going from black to white paint.

Partners: Volvo Trucks, PPG, Aearo Technologies

Heavy-Duty Vehicle Thermal Management

Experimental evaluation
CoolCalc rapid HVAC analysis
A/C model development

Top and far right photos by Dennis Schroeder, NREL
Figure and infrared image by NREL
What is the most fuel-efficient technology option for medium-duty package delivery trucks?

A. Downsize High-Efficiency Diesel
B. Hydraulic Hybrid
C. Electric Hybrid
D. It Depends
Quantifying Fuel Savings Benefits of Advanced Technologies

**UPS Hydraulic Hybrid Testing**
- Field Study of 20 hydraulic hybrid delivery vans vs. gasoline and diesel non-hybrid vans
- Chassis dynamometer testing using drive cycles developed from field measurements
- 19-56% improvement over non-hybrid – specific benefit depends on use and comparison.

*Partner: UPS, Parker Hannifin*

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**Fleet Testing and Evaluation Capabilities**
Drive cycle/duty cycle analysis
Field data collection (operations, fuel, cost, etc.)
Vehicle & engine performance data (baseline vs. new)
On-road emissions measurement
Analysis of options – identify best use of technology

**Renewable Fuels and Lubricants Laboratory**
Vehicle and engine testing
Emissions and fuel consumption measurement
Heavy-duty chassis and engine dynamometers

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*Photo by Dennis Schroeder, NREL*
On an average day of operation, how many hours does a typical package delivery truck idle?

A. 2 hours
B. 3 hours
C. 5 hours
D. 6 hours
Capturing and Analyzing Medium- and Heavy-Duty Truck Data

Medium-Duty Electric Vehicle Data Collection
• Collected 25 channels of 1-Hz propulsion system operation, use, and performance data
• Amassed data on more than 162,000 vehicle days and 4 million miles of EV operation
• Processing routines capable of handling multiple vehicles simultaneously, saving time and computing resources.

Partners: Smith, Navistar, Odyne, Shorepower, Frito-Lay, Staples, FedEx, PG&E, Coke, etc.

Fleet DNA Big Data & Analysis Characterize Real-World Operation
Operational data from over 560 trucks across 14 different vocations and a variety of powertrains currently in Fleet DNA.
• Secure archiving of sensitive fleet data
• Automated quality control and processing of data
• Publically available aggregated data and reports
• Detailed GPS drive cycle analysis
• Spatial mapping/GIS analysis/fueling rates/on-road emissions
• Integration with other databases and modeling tools.

Data and Results for:
Industry, Fleets, Government Agencies, Research Organizations
How many public compressed natural gas stations are there within 100 miles of here?

A. 7
B. 18
C. 29
D. 36
Identifying & Breaking Down Barriers to Natural Gas Technologies

New Natural Gas Engines for Vocational Trucks

- Addressed a critical gap in natural gas engine technology for medium- and heavy-duty vehicles
- Two projects focused on development, certification and commercial production of engines utilizing both compressed natural gas and liquefied natural gas
- First natural gas-powered 11.9-liter engines put into commercial production.

Partners: California Energy Commission, South Coast Air Quality Management District, Cummins Westport, Southwest Research Institute, Doosan Infracore, NGVTF

Outreach & Education

Guidance and information for fleet decision makers and policy makers
Stimulation and expansion of markets
Forums for collaboration
Online tools and data

Photo courtesy of Cummins Westport, Inc.
Next Generation Transportation Systems

Transportation Technologies and Market Fundamentals are Changing Rapidly

NREL is Expanding Efforts in the Following Areas:

• Connected and automated vehicles
• Vehicle-grid integration
• Fuel-vehicle system optimization
• Urban transportation and system planning.

Left & middle photos by Dennis Schroeder, NREL

Top illustration courtesy of U.S. Department of Transportation
Bottom illustration by Josh Bauer, NREL
Working with NREL

DOE AOP – Annual Operating Plan
DOE FOA – Funding Opportunity Announcement
Other FOA – Funding Opportunity Announcement
CRADA – Cooperative Research and Development Agreement
WFO – Work for Others
Partnership on DOE & Other Agency Projects

National Laboratories Seek to Partner with Commercial Entities to Increase Market Impact

• NREL has 650+ active partnership agreements and leads the DOE laboratory system in cooperative research agreements.

• NREL has more than 800 patented or patent-pending technologies available for licensing.

Current and Upcoming Opportunities

• 2015 Vehicle Technologies Office Funding Opportunity Announcements

• ARPA-E OPEN FOA

• SuperTruck II

• Department of Defense
Call on NREL to:

- Leverage existing technology work portfolios and partnerships
- Provide access to world-class test facilities and capabilities
- Serve as a third-party for technology validation, market acceptance, analysis, and data dissemination
- Provide systems-level energy analysis.

Learn more at www.nrel.gov/transportation