

## Project Overview: United Parcel Service's Second-Generation Hybrid-Electric Delivery Vans

Medium-duty commercial vehicles such as moving trucks, beverage-delivery trucks, and package-delivery vans consume almost 2,000 gal of fuel per year on average.<sup>1</sup> United Parcel Service (UPS) operates hybrid-electric package-delivery vans to reduce the fuel use and emissions of its fleet.

In 2008, the National Renewable Energy Laboratory's (NREL's) Fleet Test and Evaluation Team evaluated the first generation of UPS' hybrid delivery vans. These hybrid vans demonstrated 29%–37% higher fuel economy than comparable conventional diesel vans, which contributed to UPS' decision to add second-generation hybrid vans to its fleet.<sup>2</sup>

The Fleet Test and Evaluation Team is now evaluating the 18-month, in-service performance of 11 second-generation hybrid vans and 11 comparable conventional diesel vans operated by UPS in Minneapolis, Minnesota. The evaluation also includes testing fuel economy and emissions at NREL's Renewable Fuels and Lubricants (ReFUEL) Laboratory and comparing diesel particulate filter (DPF) regeneration. In addition, a follow-up evaluation of UPS' first-generation hybrid vans will show how those vehicles performed over three years of operation.

### Advanced Vehicle Testing

This project is part of a series of evaluations performed by NREL's Fleet Test and Evaluation Team for the U.S. Department of Energy's Advanced Vehicle Testing Activity (AVTA). AVTA bridges the gap between research and development and the commercial availability of advanced vehicle technologies that reduce petroleum use and improve air quality in the United States. The main objective of AVTA projects is to provide comprehensive, unbiased evaluations of advanced vehicle technologies in commercial use. Data are collected and analyzed for operation, maintenance, performance, costs, and emissions characteristics of advanced-technology fleets and comparable conventional-technology fleets operating at the same site. AVTA evaluations enable fleet owners and operators to make informed vehicle-purchasing decisions.



UPS operates 381 hybrid-electric delivery vans nationwide. This image is reproduced with permission of United Parcel Service of America, Inc. © 2011 United Parcel Service of America, Inc. All rights reserved. Photo from UPS, NREL/PIX 19821

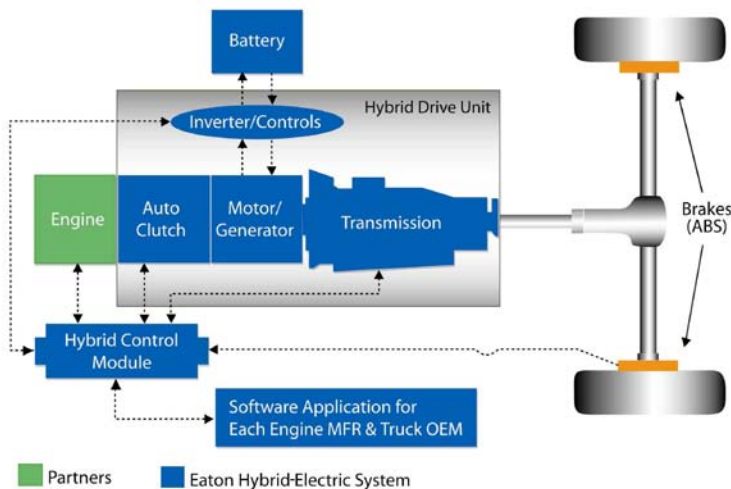
One goal of this project is to provide a consistent comparison of fuel economy and operating costs between the second-generation hybrid vans and comparable conventional vans. Additional goals include quantifying the effects of hybridization on DPF regeneration and helping UPS select delivery routes for its hybrid vans that maximize the benefits of hybrid technology. This document introduces the UPS second-generation hybrid evaluation project. Final results will be available in mid-2012.

### UPS' Hybrid-Electric Delivery Vans

As part of its commitment to reducing fuel use and emissions, UPS operates more than 2,500 natural gas, propane, electric, and hybrid-electric vehicles worldwide. The company uses its advanced vehicles as a "rolling laboratory" to learn how the technologies can best serve a large delivery fleet. It also works with manufacturers, government agencies, and non-profit organizations to advance and demonstrate newly developed vehicle technologies.

Following small-scale pilot hybrid demonstrations in 2000 and 2004, UPS deployed 50 hybrid-electric vans among four U.S. cities in 2007. The Fleet Test and Evaluation Team evaluated this first generation of hybrid-electric vans as described above. In 2010, UPS deployed 200 second-generation hybrid-electric vans among eight U.S. cities. These vehicles are the subject of the current evaluation.

The hybrid-electric vans are equipped with a parallel hybrid system manufactured by Eaton Corp. The system includes a synchronous, brushless, permanent-magnet motor (26-kW continuous power, 44-kW peak power); regenerative braking; and lithium-ion batteries that provide 340 volts direct current



UPS' hybrid-electric delivery vans use Eaton's parallel hybrid system. *Courtesy of Eaton Corp.*

and 1.8 kWh of energy storage. Torque from the electric motor augments torque from the vehicle's engine, which can improve fuel economy and performance. Energy that is normally lost during braking is captured, stored in the batteries, and used to power the electric motor. In certain situations, the engine shuts off when the vehicle is stopped to eliminate fuel use and emissions due to idling—this feature is an enhancement over the first-generation vans.

### In-Service Testing in Minneapolis

NREL started its evaluation of the 11 hybrid and 11 diesel vans in July 2010. The vans serve similar routes in UPS' Minneapolis delivery area. The routes were evaluated with the help of Global Positioning System (GPS) data loggers, and the study vehicles will switch routes part way through the study to improve the comparability of the routes driven by each van type over the entire study period.

The following information will be evaluated during the study to enable comparison of the hybrid and diesel van fuel economies, operating costs, emissions, and DPF regeneration characteristics:

- Vehicle fueling data from fueling records, engine control modules, and data loggers
- Vehicle mileage data from driver logs, engine control modules, and data loggers
- Vehicle maintenance data from service reports
- DPF regeneration data from engine control module trip information downloads.

### Test Vehicle Specifications

	Hybrid Electric	Conventional Diesel
Chassis manufacturer/model	Utilimaster P100H	Morgan Olson Freightliner P100D
Chassis model year	2010	2010
Engine manufacturer/model	Cummins ISB	Cummins ISB
Engine model year	2009	2009
Engine emissions certifications	EPA and CARB	EPA and CARB
Engine ratings Maximum horsepower Maximum torque	200 hp @ 2,300 rpm 520 ft-lbs @ 1,600 rpm	200 hp @ 2,300 rpm 520 ft-lbs @ 1,600 rpm
Diesel fuel capacity	30 gal	30 gal
Transmission manufacturer/model	Eaton automated manual	Allison Auto HS 2200 Series
Curb weight (lb)	12,000	10,800
Gross vehicle weight rating (lb)	23,000	23,000
Retarder/regenerative braking	Regenerative brakes	N/A
Advanced emission-control equipment	DPF	DPF
Cabin air conditioning	No	No
Rear axle ratio	4.10	4.10

EPA—U.S. Environmental Protection Agency  
CARB—California Air Resources Board

### Chassis Dynamometer Testing at the ReFUEL Laboratory

One hybrid and one diesel van will be tested at NREL's ReFUEL Laboratory in Denver, Colorado. The drive cycles for this chassis dynamometer testing will be determined using in-service data collected from GPS data loggers. Fuel economy and emissions of nitrogen oxides, carbon monoxide, hydrocarbons, and carbon dioxide will be measured for each van.

To track the progress of the UPS hybrid van evaluation project, visit the AVTA ([www.eere.energy.gov/vehiclesandfuels/avta](http://www.eere.energy.gov/vehiclesandfuels/avta)) and Fleet Test and Evaluation ([www.nrel.gov/vehiclesandfuels/fleettest](http://www.nrel.gov/vehiclesandfuels/fleettest)) Web sites. Interim and final project reports will be posted on these sites as they are published.

1 Calculated from statistics for Class 4-6 trucks (gross vehicle weight rating of 14,001-26,000 lb) in the Transportation Energy Data Book, Edition 29, Oak Ridge National Laboratory, 2010 (<http://cta.ornl.gov/data>).

2 For results of the first-generation evaluation, see United Parcel Service Evaluates Hybrid Electric Delivery Vans, National Renewable Energy Laboratory, 2010 ([www.nrel.gov/docs/fy10osti/47327.pdf](http://www.nrel.gov/docs/fy10osti/47327.pdf)).