Interim Project Results: United Parcel Service's Second-Generation Hybrid-Electric Delivery Vans

As part of its commitment to reducing fuel use and emissions, the United Parcel Service (UPS) operates more than 2,500 natural gas, propane, electric, and hybrid-electric vehicles worldwide. The company uses these advanced vehicles as a "rolling laboratory" to learn how such technologies can best serve its large delivery fleet.

The U.S. Department of Energy's National Renewable Energy Laboratory (NREL) has a long history of helping UPS determine the impact of hybrid technology on fuel use, emissions, and operating costs. In 2008, NREL's Fleet Test and Evaluation Team evaluated the first generation of UPS' hybrid delivery vans, which demonstrated 29%–37% higher fuel economy than comparable conventional diesel vans.[1]

Hybrid electric parcel delivery vehicle. *Photos by Jon Cosgrove, NREL/PIX 19815, NREL/PIX 19816*

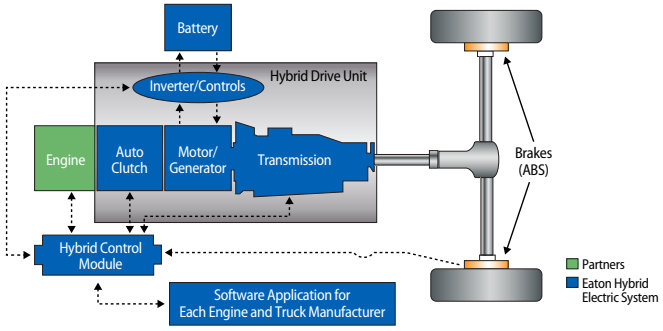
Encouraged by this success, UPS added 200 second-generation hybrid vans to its delivery fleet in 2010. These second-generation vehicles feature a new "engine off at idle" capability to further boost fuel economy. NREL's Fleet Test and Evaluation Team is in the process of evaluating the 18-month, in-service performance of 11 of these second-generation hybrid vans along with 11 comparable conventional diesel vans operating in Minneapolis, Minnesota.

As a complement to the ongoing field study, the team recently completed fuel economy and emissions testing at NREL's Renewable Fuels and Lubricants (ReFUEL) Laboratory.

Vehicle Specifications

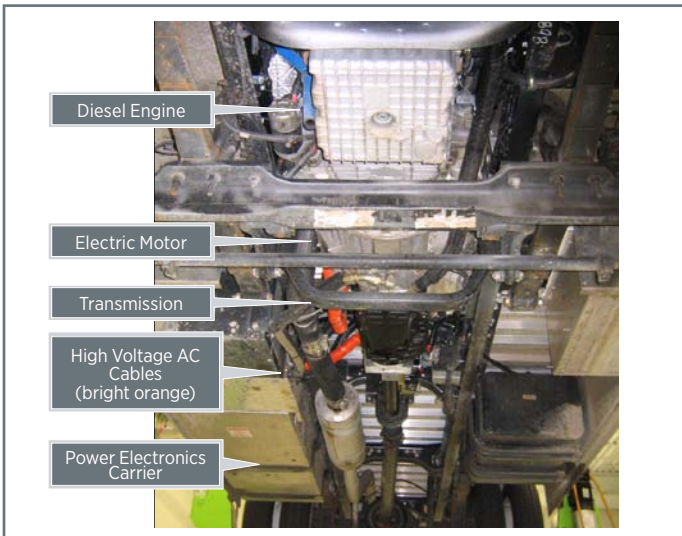
The following table provides a side-by-side comparison of the second-generation hybrid vans and their conventional counterparts.

Vehicle Specifications	Hybrid Electric	Conventional Diesel
Van Manufacturer	Freightliner Corp.	Freightliner Corp.
Van Model	P100H step van	P100D step van
Van Model Year	2010	2010
Engine Manufacturer and Model	Cummins ISB 200 hp MY 2009	Cummins ISB 200 hp MY 2009
Emissions Equipment	DPF	DPF
Retarder/Regenerative Braking	Regenerative braking	None
Air Conditioning Type	None	None
GVWR	23,000 lbs	23,000 lbs



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

The hybrid vans are equipped with parallel hybrid systems manufactured by Eaton Corp., as displayed in the diagram above. These systems include a synchronous, brushless, permanent-magnet motor (26-kW continuous power and 44-kW peak power); regenerative braking (energy normally lost during braking is used to power the electric motor); and lithium-ion batteries (340 volts of direct current and 1.8 kWh of energy storage).



Underside of parcel delivery vehicle. *Photo courtesy of UPS*

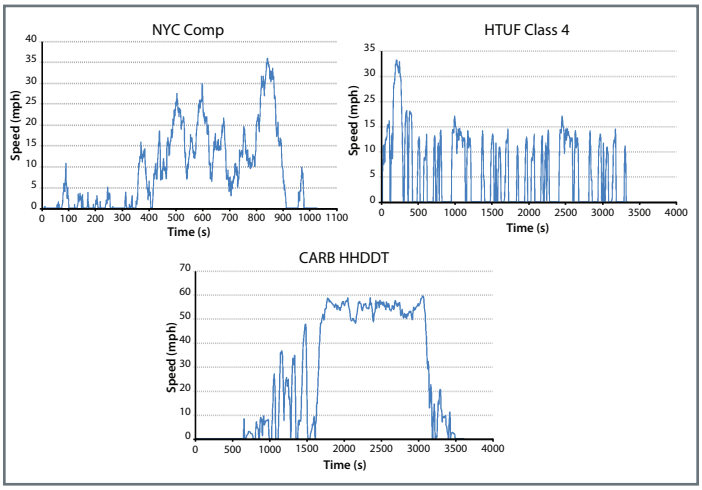
1 For results of the first-generation evaluation, see United Parcel Service Evaluates Hybrid Electric Delivery Vans, National Renewable Energy Laboratory, 2010 (***www.nrel.gov/docs/fy10osti/47327.pdf***).

Vehicle Testing in Laboratory

Using the dynamometer at the ReFUEL Laboratory, the team tested one hybrid van and one conventional van on three standard drive cycles, selected based on in-use data collected by NREL.

Parcel delivery vehicle on dynamometer. *Photo by Jon Cosgrove, NREL/PIX 19813*

Drive Cycle Statistics	NYC Comp	HTUF 4	HHDDT
Average Speed over Cycle (mph)	8.8	12.1	26.0
Average Driving Speed (mph)	13.1	22.5	35.6
Stops per Mile	8.0	2.5	0.5
Aerodynamic Speed (ft/s)	30.4	44.5	74.4
Characteristic Acceleration (dt/s/s)	-0.75	-0.57	-0.18
Kinetic Intensity (1/mile)	4.30	1.51	0.17



Test Results

Depending on the drive cycle, the hybrid van demonstrated a 21%–45% improvement in ton-mile/gallon fuel economy compared to the conventional van. These dynamometer test results represent statistically significant improvements at the 95% confidence level.

Ton Fuel Economy	NYC Comp	HTUF 4	HHDDT
Conventional P100D (ton-mi./gal)	51.1	56.2	72.0
Hybrid P100H (ton-mi./gal)	70.9	81.6	87.2
Hybrid Advantage (%)	39%	45%	21%

Fuel Economy	NYC Comp	HTUF 4	HHDDT
Conventional P100D (mpg)	6.8	7.5	9.6
Hybrid P100H (mpg)	8.8	10.1	10.8
Hybrid Advantage (%)	29%	36%	13%

Fuel Savings

Extrapolating on these fuel economy results, the hybrid vans could save 0.7–2.4 gallons per day per van (or 176–610 gallons per year per van), depending on drive cycles and daily mileage. With the 11 hybrid vans in Minneapolis alone, UPS could reduce its diesel use by 1,900–6,700 gallons a year and save up to $23,000 (at $3.43/gallon) in fuel costs.

Gallons Saved per Van Day of Operation								
Miles per Day	30	40	50	60	70	80	90	100
NYC Comp	1.0	1.3	1.7					
HTUF 4	1.0	1.4	1.7	2.1	2.4			
HHDDT				0.7	0.8	0.9	1.9	1.2

Gallons Saved per Van Year of Operation								
Miles per Day	30	40	50	60	70	80	90	100
NYC Comp	254.7	339.6	424.5					
HTUF 4	261.5	348.7	435.9	523.1	610.3			
HHDDT				176.4	205.8	235.2	264.6	294.0

More Results to Come

Results-to-date are based on dynamometer testing at NREL's ReFUEL Laboratory. The ongoing field study will offer additional results, with a focus on in-use fuel economy, maintenance costs, operating costs, diesel particulate filter regeneration, and reliability of the hybrid vans compared to their conventional counterparts. These results will be detailed in an upcoming project report. For more information about this and other evaluation projects, visit NREL's Fleet Test and Evaluation website at *www.nrel.gov/vehiclesandfuels/fleettest*.

Advanced Vehicle Testing

This evaluation is part of a series of evaluations performed by NREL's Fleet Test and Evaluation Team with funding from the Advanced Vehicle Testing Activity (AVTA), which is managed by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE). AVTA projects provide comprehensive, unbiased evaluations of advanced vehicle technologies in commercial use, enabling fleet owners and operators to make informed vehicle-purchasing decisions. All publications regarding the UPS hybrid delivery van evaluation are posted in the medium- and heavy-duty vehicles section of the EERE website at *www.eere.energy.gov/vehiclesandfuels/avta*.

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