

Partners



The technical organizations that contributed to the development of the UPS hydraulic hybrid demonstration vehicles are: U.S. EPA, UPS, Eaton Corporation, International Truck and Engine Corporation, and the U.S. Army – National Automotive Center. Major technical support was provided by FEV Engine Technology, Inc., Southwest Research Institute and Morgan-Olson.



EPA does not endorse any specific company or enterprise.

CLEAN AUTOMOTIVE TECHNOLOGY



INNOVATION THAT WORKS

An EPA Program

EPA's Clean Automotive Technology Program conducts this innovative research primarily to:

- Achieve ultra-low pollution emissions
- Reduce greenhouse gases
- Increase fuel efficiency

By developing cost-effective technologies, the Clean Automotive Technology program also encourages manufacturers to produce cleaner and more fuel-efficient vehicles. Fleet owners benefit by being able to recoup the initial hybrid system costs through lower operating costs within a few years.

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Environmental Protection Agency**

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HYDRAULIC HYBRID VEHICLES

**THE WORLD'S
MOST EFFICIENT, LOWEST COST
HYBRIDS**



World's First Full
Series Hydraulic Hybrid
Delivery Vehicle Prototyped in a
UPS "Package Car"

HHV-HYDRAULIC HYBRID VEHICLES

HIGHEST EFFICIENCY - LOWEST COST

Using innovative series hydraulic hybrid technology EPA and its industry partners have created a highly efficient and cost-effective hybrid powertrain technology. EPA has been able to improve city fuel economy of a UPS package car by 70 percent and reduce CO₂ greenhouse gas emissions by 40 percent. The unique energy recovery technology used while braking reduces brake wear by 75 percent, increasing the net savings substantially.

A fleet owner operating one of these high efficiency vehicles would save up to 1,000 gallons of fuel each year.

Even more remarkable, when this technology is manufactured in high volume it has the potential to cost less than 15 percent of the price of the base vehicle price; this means owners could recoup the hybridization costs from fuel and maintenance savings in three to five years.

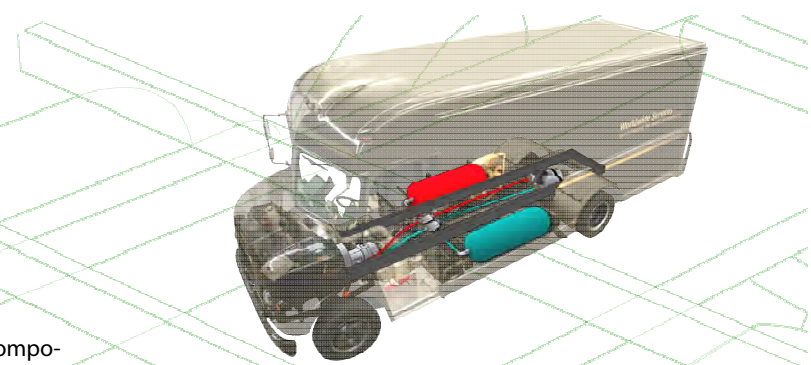
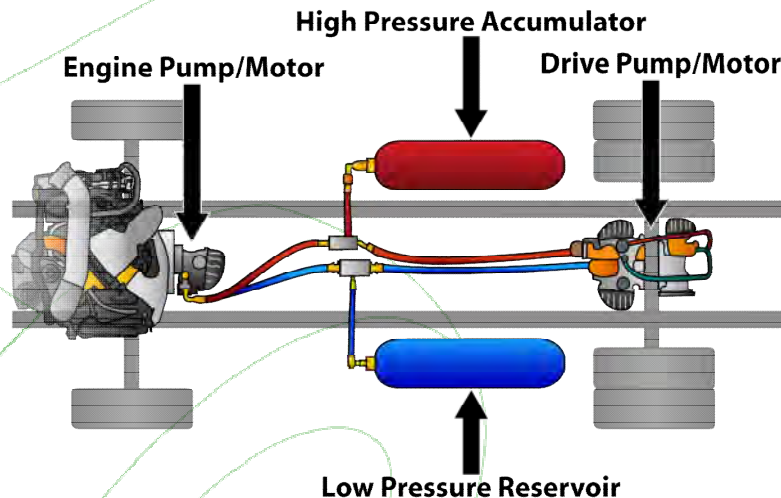
The net lifetime savings over this vehicle's typical 20 year lifespan would be over \$50,000.

Hydraulic hybrid vehicles rely on proven innovative technology which can be applied to light-duty work trucks, SUVs and heavy-duty urban vehicles such as city transit buses and garbage trucks.

HOW IT WORKS

This innovative technology is simple. The main components in a full series hydraulic hybrid vehicle are:

- **High pressure accumulator**— stores energy by using hydraulic fluid to compress nitrogen gas much as a battery is used to store energy in a hybrid electric vehicle.
- **Rear drive pump/motor (acting as a motor)**— converts pressurized hydraulic fluid into rotating power for the wheels.
- **Low pressure reservoir**— stores the low pressure fluid after it has been used by the pump/motor.
- **Rear drive pump/motor (acting as a pump)**— captures braking energy by pumping hydraulic fluid back into the high pressure accumulator.
- **Engine pump/motor (acting as a pump)**— creates additional high pressure fluid needed to drive the vehicle, storing any excess in the high pressure accumulator.
- **Hybrid controller**— monitors the driver's acceleration and braking, and commands the hybrid system components.



The three key design features that improve the fuel efficiency of hydraulic hybrid vehicles are:

1. **Regenerative Braking**—To slow or stop the vehicle, the rotating energy of the wheels is used to pump fluid from the low pressure reservoir into the high pressure accumulator. This stored energy is then used to accelerate the vehicle. Up to 70 percent of the energy normally wasted during braking is recovered and reused.
2. **Engine Shutoff (idle reduction)**— The unique hybrid design not only allows the engine to be operated at its maximum efficiency, but also enables the engine to be completely shut off during certain stages of operation because it is activated by the controller only when it is needed. As a result, engine use is cut almost in half in stop and go urban city driving.
3. **Optimum Engine Control**— In the full series hybrid design, there is no conventional transmission and driveshaft to connect the engine directly to the wheels. This frees the engine to be operated at its best efficiency "sweet" spot, achieving optimum vehicle fuel economy.